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THE ROENTGEN-RAY EVALUATION OF BREAST SYMPTOMS*

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THE roentgen examination offers a diagnostic method in the study of diseases of the breast that is comparable to the gross examination of excised tissue. The pathological state responsible for any of the cardinal presenting breast symptoms, tumor, pain or discharge from the nipple, can often be recognized without exploratory section. The need for biopsy can be reduced in many tumors that are clinically only suspicious but prove to be roentgenologically characteristic. There are several limitations of the roentgen examination shared by any method of gross observation: The inability to recognize, (*a*) microscopic areas of cancer, (*b*) early malignant degeneration in benign tumors and (*c*) early carcinoma associated with chronic cystic mastitis.

The technique of examination has been described in detail in previous reports.[11,12] Several roentgenograms using different exposures may be necessary to establish a clear concept. The value of serial study in the diagnosis of certain conditions cannot be overestimated.[7]

The classification of breasts divided into the normal, chronic mastitis and chronic cystic mastitis proved inadequate early in our investigation. After comparison of roentgenograms of many breasts with the tissue of operated cases, a division based on Cheatle and Cutler's[3] work was found satisfactory. They describe two distinct histological patterns in the breast—mazoplasia and cystiphorous desquamative epithelial hyperplasia. Mazoplasia is the term given to the type of desquamation of epithelial cells in the terminal ducts and their acini accompanied by hyperplasia of the pericanalicular and periacinous connective tissue and often with the formation of ducts and acini, which is a physiological process. On the roentgenogram (Case 1) this state is characterized by a frond-like appearance of the parenchyma. The converging striations form a fine indistinct band beneath the nipple and there is a varying amount of non-opaque stroma between the mass of the gland and the derma.

CASE 1. Miss M., aged twenty-five. Premenstrual pain and fullness of the breasts. No discharge from the nipple.

Roentgen Examination. Characteristic appearance of mazoplasia. Roentgenograms of the right breasts are shown (Fig. 1). The one to the left was made midway between the menstrual periods, and the one to the right at onset of menstruation. The changes are faint but constant in this type of breast. An increase in the exposure obliterates these changes and leaves only the fibrous tissue stroma visualized.

Cystiphorous desquamative epithelial

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hyperplasia begins as a desquamative epithelial hyperplasia that ends in the formation of cysts. These breasts are often "shotty" to palpation and correspond fairly well to the state of chronic cystic mastitis. It is in these breasts that both large and small cysts are found. In the roentgenogram (Case II) the parenchyma the breasts is intermittent and has no constant relation to the menses.

Roentgen Examination. There is no perceptible difference in the roentgen appearance in the film made midway between the menstrual periods (to the left) and the one made at the onset of menstruation (to the right) (Fig. 2).

Between these two extremes are breasts

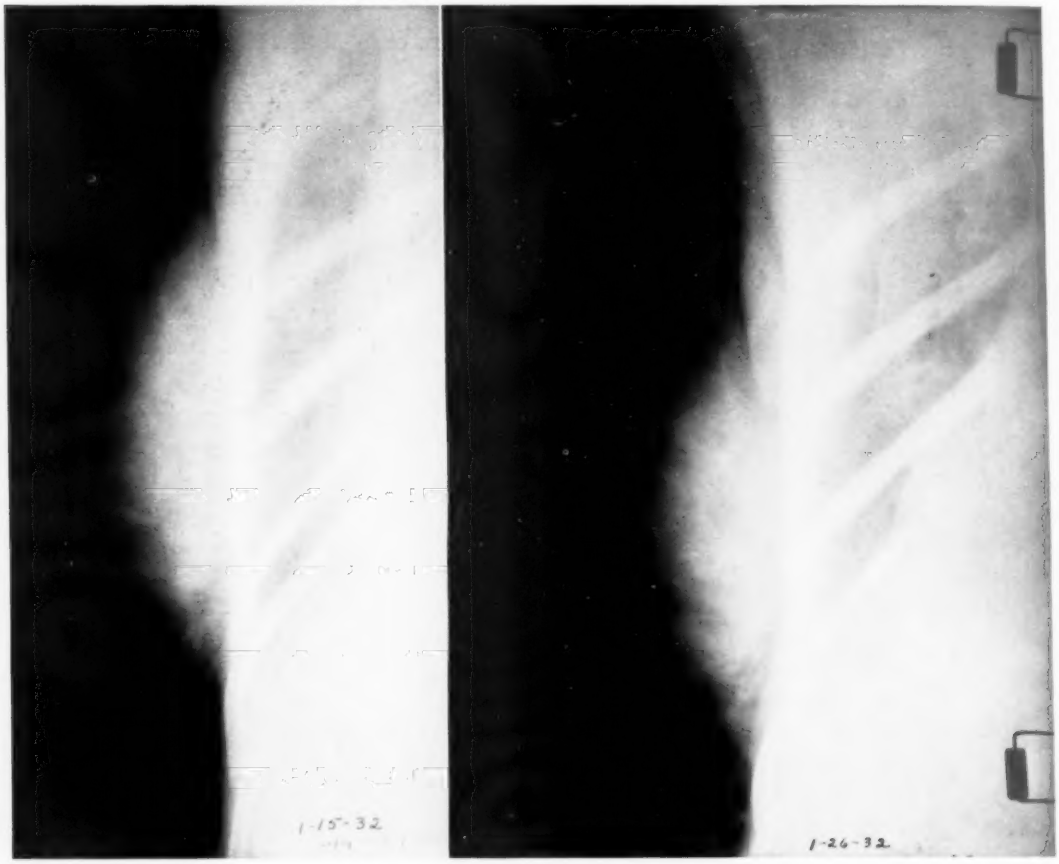

FIG. 1. Case I. Mazoplasia. Patient aged twenty-five. The breast to the left midway between menstrual periods, the one to the right at onset of menstruation.

appears to fill all the available space to the derma. There is a broad dense band beneath the nipple. Scattered throughout the breast are many small clear areas measuring 1 to 4 mm. in diameter representing small cysts. Large cysts of the blue dome variety appear as large irregular clear spaces in the parenchyma of the gland.

CASE II. Miss C., aged twenty. Cystiphorous desquamative epithelial hyperplasia. Pain in

showing characteristics of each type. Whether one accepts Cheatle's or Handley's[8] explanation of the histological changes accompanying these different states each presents a typical appearance on the roentgenogram. There is considerable evidence that the previous state of the gland can be predicted after involution has taken place. The roentgenogram after the menopause, either natural or artificial, shows a

replacement of the glandular parenchyma by non-opaque fat. This replacement is far more complete in mazoplasia than in chronic cystic mastitis. The changes in cystiphorous desquamative epithelial hyperplasia remain long after the climacteric and one finds persistence of the broad band beneath the nipple and a varying number of small cysts (Fig. 15).

roentgenologically demonstrable changes in the stroma of the breast.

In the breast showing mazoplasia there is premenstrually roentgenologically perceptible accentuation of the rather faint shadows of the parenchyma with a slow but progressive regression afterwards, with the gland clearest midway between the menstrual periods (Case 1). That this is a con-

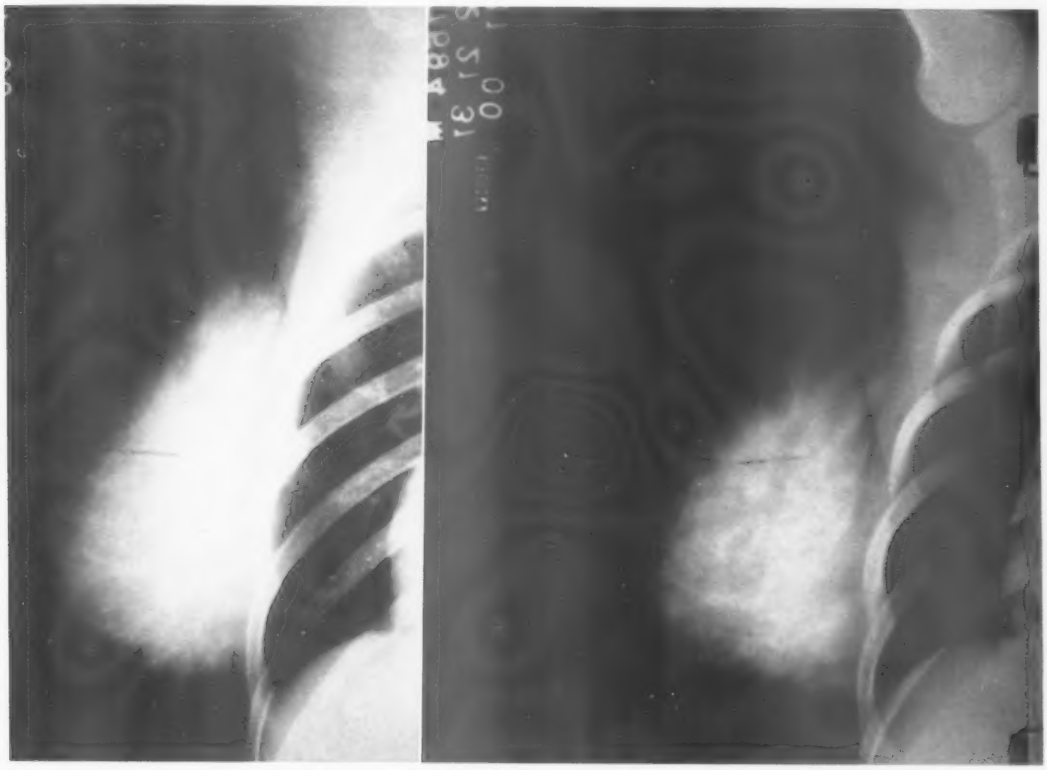

Fig. 2. Case II. Cystiphorous desquamative epithelial hyperplasia. Patient aged twenty-five. The breast to the left midway between menstrual periods, the one to the right at onset of menstruation.

PAIN

Premenstrual pain in the breasts is a frequent complaint. The roentgenologic appearance of the menstrual changes is of considerable interest. These changes may be slight and involve principally the glandular structure, and to show them the technique must be exact. Too great an exposure will obliterate the parenchyma, leaving only the fibrous tissue network of the breast visible. It is hardly conceivable that each menstruation would be accompanied by

stant finding has been demonstrated by negatives made at three to four day intervals throughout the menstrual cycle.

In the presence of cystiphorous desquamative epithelial hyperplasia there is little if any difference in the roentgenologic appearance of the breasts midway between the periods and at the onset of the menses (Case II). This suggests that therapy based on ovarian residue, as suggested by Cutler,[5] may be adequate to modify the premenstrual changes of mazoplasia but not influ-

ence the constant hyperplasia of the cystiphorous state.

Pain is a symptom that brings both malignant and non-malignant conditions to the attention of the individual. It is not a usual symptom in carcinoma and when present is usually a late manifestation indicative of metastasis. It is often associated with inflammatory changes leading to fibrosis.

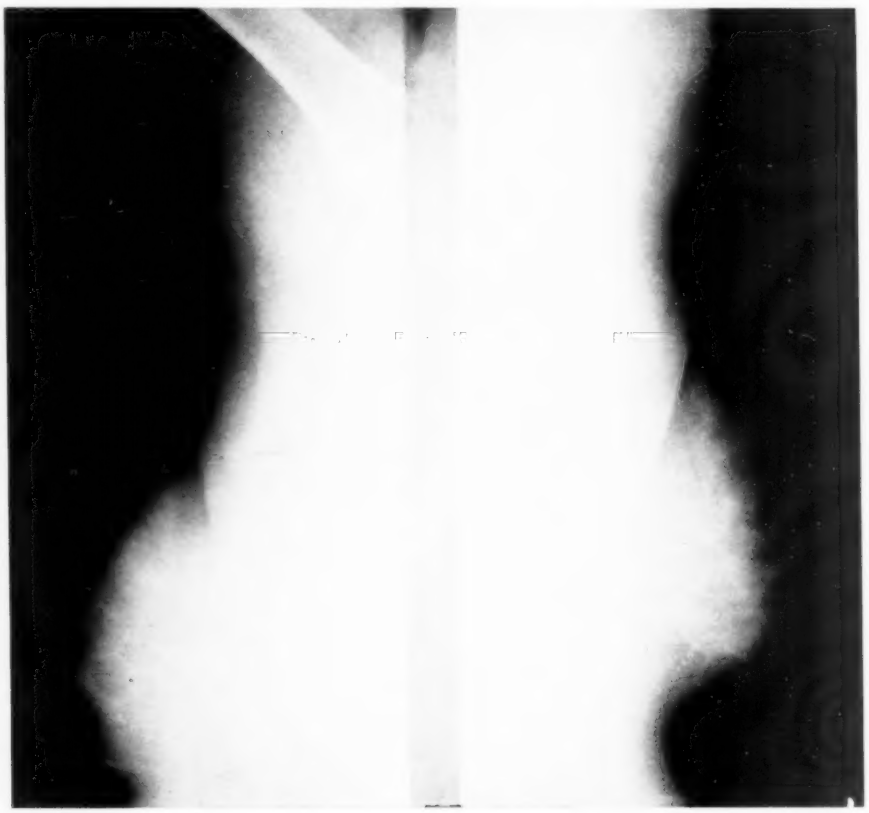

FIG. 3. Case III. Intraductal papillomata left breast. Patient aged thirty-two. Roentgen evidence of cystiphorous desquamative epithelial hyperplasia.

DISCHARGE FROM THE NIPPLE

The significance of a serohemorrhagic or a hemorrhagic discharge from the nipple is a moot point. Bloodgood[2] is of the opinion that it is more often evidence of a benign rather than a malignant lesion and that blood from the nipple appears before a palpable tumor in but 1 per cent of the cases of carcinoma of the breast. Deaver and McFarland[6] state that a bloody discharge from the nipple is due in the majority of cases to papillary growths or to benign intracanalicular papillomas. Adair[1] says that a dark bloody discharge always means a duct carcinoma. However, the consensus of opinion seems to be that discharge from the nipple cannot be regarded as of great significance in differential diagnosis.[14]

In our experience bleeding from the nipple has been associated more often with intraductal papillomas. There are no characteristic roentgen findings to identify these microscopic lesions. One finds, however, roentgen evidence of cystiphorous desquamative epithelial hyperplasia. This, with the bleeding from the nipple, warrants a presumptive diagnosis of papillomata in the absence of a mass or a roentgenologically demonstrable tumor. Bleeding due to

cancer comes from invasion of the ducts or acini and hence is usually accompanied by a distinct mass.

Case III. Mrs. H., aged thirty-two. During the last year has had some tenderness in the left breast with intermittent bleeding for the past fifteen days. No evidence of a palpable mass.

Roentgen Examination. The signs of cystiphorous desquamative epithelial hyperplasia are present. Papillomata would be expected to supervene at this age. In the absence of a mass and with bleeding from the nipple in the presence of the cystiphorous state, a presumptive diagnosis of papillomata was made (Fig. 3).

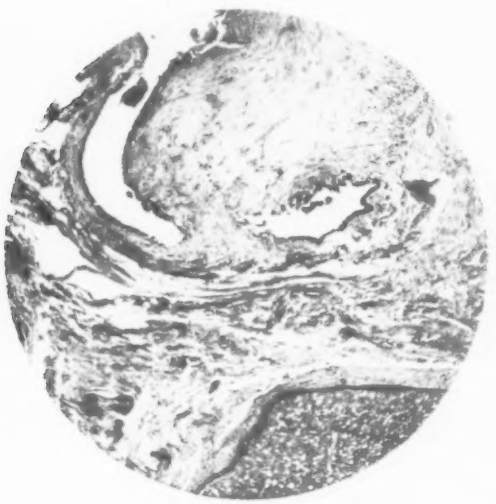

Fig. 4. Case III. Photomicrograph showing section of intraductal papillomata. No evidence of malignancy.

Histology. Intraductal papillomata. No evidence of malignancy (Fig. 4).

TUMORS OF THE BREAST

The nature of benign tumors can usually be predicted by the roentgen examination.[13] Fibroadenoma is the only tumor that can be traced directly to mazoplasia.[3] The following case was clinically considered to be a cyst but the roentgen appearance was that of a fibroadenoma.

Case IV. Mrs. D., aged thirty-seven. Patient has been aware of a lump in the right breast for six months, clinically considered a cyst.

Fig. 5. Case IV. Fibroadenoma in lower pole of right breast.

Roentgen Examination. Both breasts show mazoplasia. In the lower pole of the right breast there is a regular dense mass with distortion but no interruption of the striations characteristic of a fibroadenoma (Fig. 5).

Histological confirmation of the roentgen findings (Fig. 6).

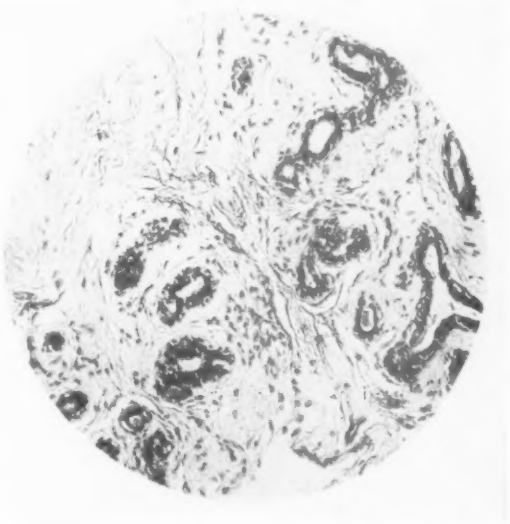

Fig. 6. Case IV. Photomicrograph showing typical fibroadenoma.

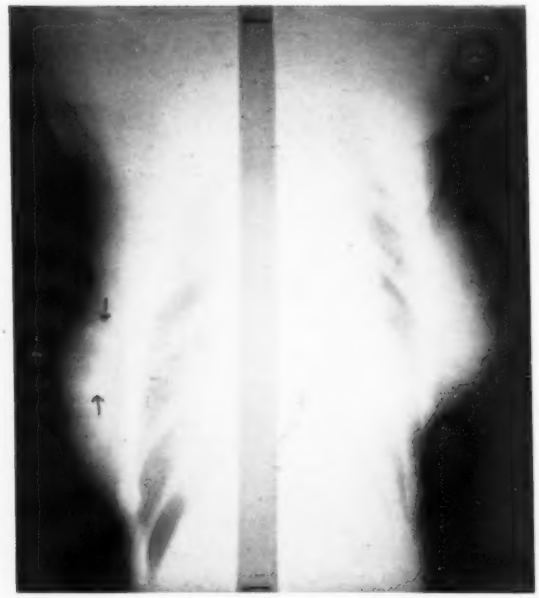

FIG. 7. Case v. Chronic cystic mastitis, right breast.

Cysts are associated with the state of cystiphorous desquamative epithelial hyperplasia. They appear as large, irregular, relatively clear areas in the parenchyma of the gland. If a cyst arises in a localized area of the cystiphorous state it presents the appearance of a faint solid tumor without the dense well-defined outline.[13]

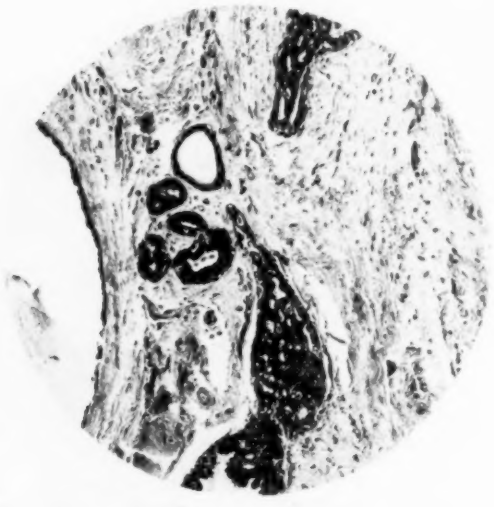

FIG. 8. Case v. Photomicrograph of tissue from the opaque area. No evidence of malignancy.

CASE v. Mrs. L., aged fifty-five. Menopause fifteen years ago. Patient complains of swelling of the breasts and states that there has been a painful lump in the right breast for several years; clinically it was considered to be a benign lesion.

Roentgen Examination. Even fifteen years after the menopause evidence of a previous cystiphorous state remains in the broad band beneath the nipple and several small cysts. In the upper quadrant there is an irregular mass with no evidence of alteration in the striations or axillary invasion. The mass reaches but does not infiltrate the muscle planes. The glandular atrophy permits greater density of the mass than the stroma. There are several clear, irregular areas suggestive of cysts (Fig. 7).

FIG. 9. Case VI. Retromammary mass with lymph nodes in each axilla. Histologic diagnosis: Hodgkin's disease.

Extra-mammary tumors are occasionally encountered. They may appear to arise in the breast tissue. The value of the roentgen examination is shown in the following case of Hodgkin's disease.

CASE VI. Miss A., aged twenty. Three months ago a painless lump in the right breast developed, gradually increasing in size; nodules have been found in the axilla.

Roentgen Examination. There is an extra-

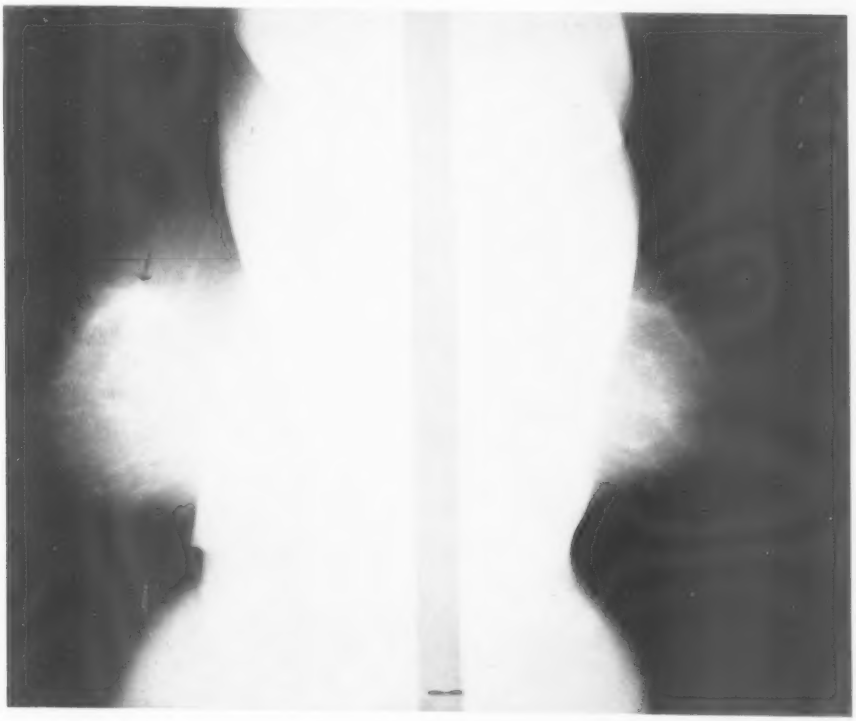

Fig. 10. Case VII. Fibrosis. Area of fibrosis in right breast after injury.

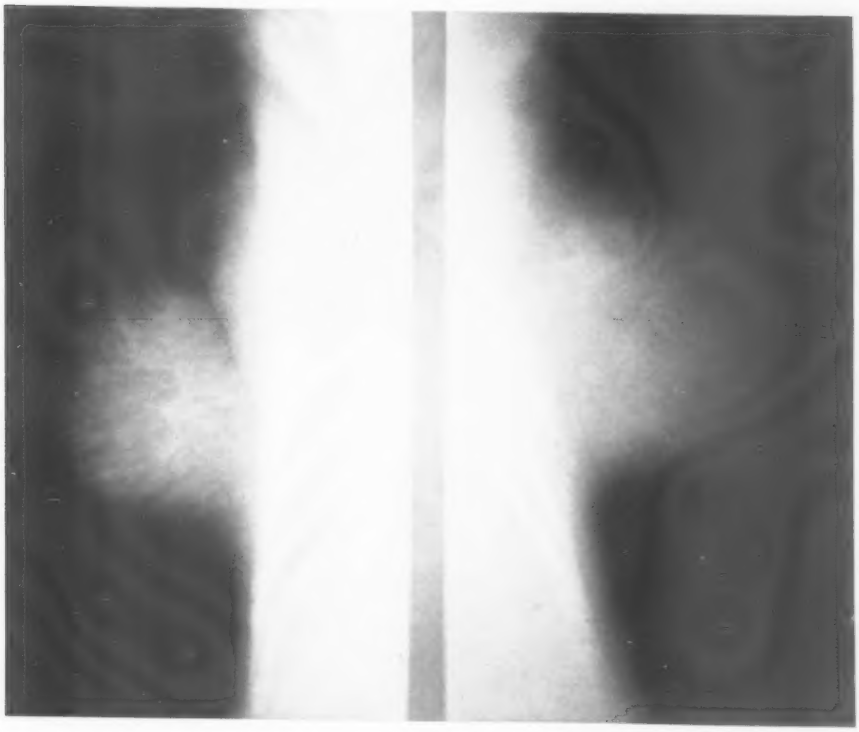

Fig. 11. Case VIII. Fibrosis. Scattered areas of fibrosis in each breast. Irregular lymph node shadow in right axilla.

mammary tumor that compresses and displaces the tissue of the right breast forward without infiltration of the muscle plane. In the upper pole there is a defect in the parenchyma marking the site of a recent biopsy in which only normal breast tissue was recovered. There are several smooth rather dense glands visible in each axilla (Fig. 9).

Subsequent biopsy of a lymph node showed the histological findings of Hodgkin's disease.

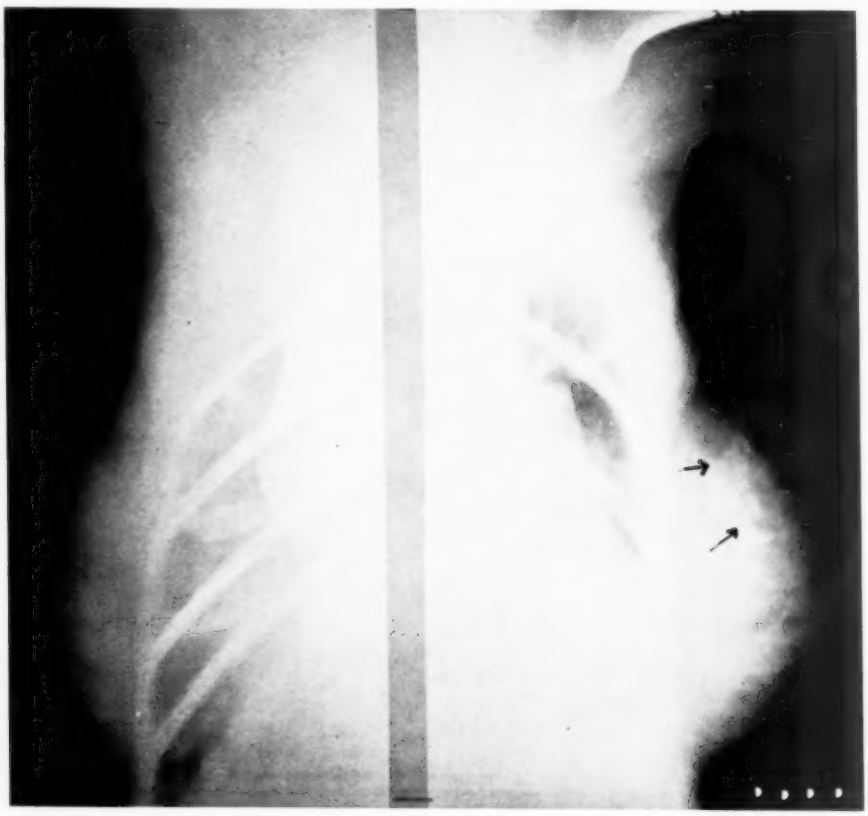

FIG. 12. Case IX. Carcinoma in the left breast with bilateral chronic cystic mastitis. Operative confirmation.

Fibrosis of the breast from local trauma, chronic lactation mastitis,[4] or arising in connection with desquamative epithelial hyperplasia, chronic cystic mastitis, either localized or general, may give a clinical picture simulating carcinoma. Often at operation these areas are deceptive and final diagnosis rests on the microscopical examination. The roentgen appearance is often not as confusing as the clinical. One sees on the negatives, except in the cases of local trauma, many irregular faint masses of scar tissue involving both breasts with fine lines extending into the axilla. Lymph nodes when visualized are faint and irregular in outline with no change in the clear space separating the base of the breast from the pectoral muscles[15] and no distortion of the striations.

CASE VII. Miss C., aged thirty-three. Had a severe injury to the right breast one year ago followed by a small painful lump.

Roentgen Examination. In the upper pole of the right breast there is a well-outlined but irregular dense mass with some distortion of the striations but no axillary invasion (Fig. 10).

This case has been followed for a year with no change evident in this area.

CASE VIII. Mrs. M., aged thirty. For the past fifteen days the breasts have been very painful. No history of injury and no discharge from the nipple.

Roentgen Examination. Scattered throughout each breast are many irregular fine areas of fibrosis with extension into the axilla. There is the shadow of a lymph node in the right axillary space (Fig. 11).

The roentgen identification of early carcinoma in the presence of chronic cystic mastitis before the menopause is not always possible. Similar difficulties are encountered at operation or even at gross examination after the removal of the breast. Cancer may not be recognized in the presence of mastitis before the tumor reaches one centimeter in diameter. Identification of cancer by any means before this size is reached is more often the result of accident than design. An increase of kilovoltage (average 10) will obliterate a major portion of the parenchyma and usually leave the cancerous mass exposed, the cancer appearing as a rather dense irregular tumor often with a feathered periphery with interruption of the striations. Later there is regional obliteration of the smooth muscle plane.[10] The cancerous lymph node in the axilla appears as a smooth, rather dense opaque area, while the inflammatory node is faint and irregular in outline. Carcinoma

Fig. 13. Case x. Cancer. Irregular mass beneath left nipple.

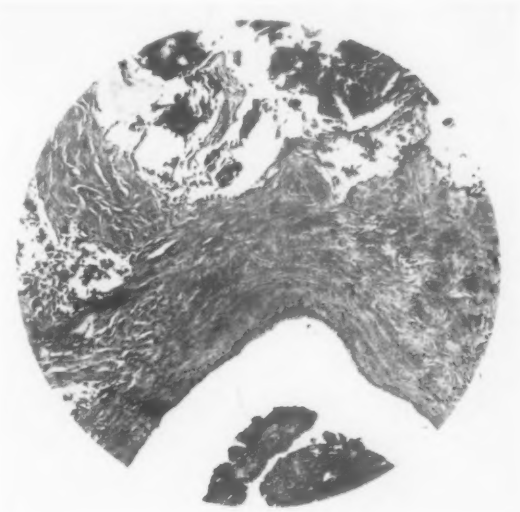

Fig. 14. Case x. Photomicrograph. Adenocarcinoma.

is prone to affect the "tail of the breast," a peculiarity that allows the mass to be projected with little superimposition of other tissue and a factor that aids in the roentgen diagnosis and remains one of the serious obstacles to transillumination.

Case ix. Miss W., aged thirty-nine. There is a painful lump in the left breast that has been present for several years and has been slowly increasing in size.

Physical examination inconclusive.

Roentgen Examination. There are marked cystiphorous changes in each breast. In the upper pole of the left breast there is an irregular cystic mass with several smaller areas more dense than the breast parenchyma. There is a loss of the striations in this region and feathery extension into the left axilla. No lymph nodes visualized (Fig. 12).

Pathological Examination. Carcinoma of the breast without microscopic evidence of lymph node involvement.

The difficulties of the roentgen identification of early carcinoma are not found in the majority of individuals who come for an examination with the history of a lump in the breast, as 81 per cent of the cases are encountered after the age of forty[9] when the involutional changes have left the breast largely fat in which a cancerous mass stands out in relief.

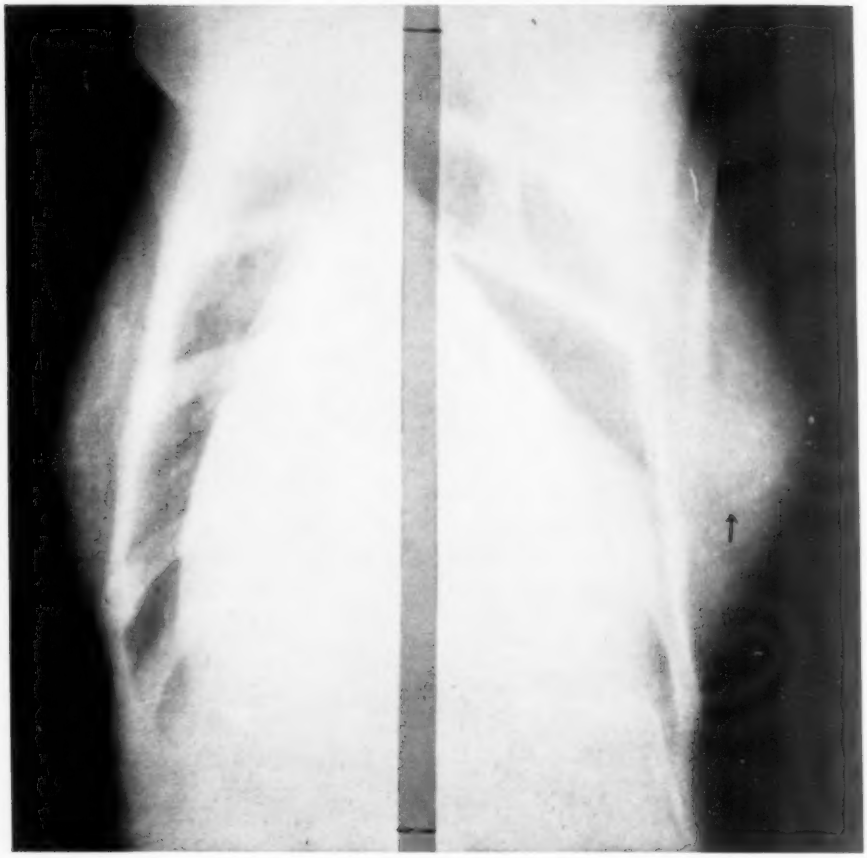

Fig. 15. Case xi. Cancer. Involutional atrophy in both breasts. Cancerous mass in left breast.

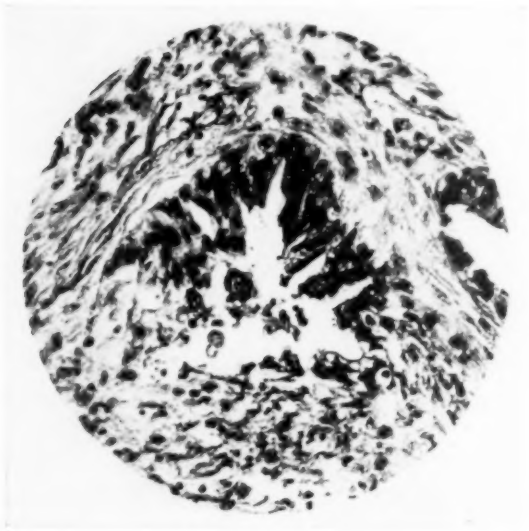

Fig. 16. Case xi. Photomicrograph. Adenocarcinoma.

Case x. Mrs. A., aged sixty-four. Patient has been aware of a painless lump in the left breast for the past two weeks.

Roentgen Examination. An irregular mass is seen beneath the left nipple; it has a feathered periphery with distortion of the pyramid but no evidence of axillary involvement (Fig. 13).

Radical operation was performed without biopsy from the roentgen findings with histological confirmation of carcinoma (Fig. 14).

Case xi. Mrs. G., aged sixty-three. Five months ago patient noticed a painful tumor in the left breast that has slowly increased in size.

Roentgen Examination. There is an irregular tumor mass in the lower part of the left breast that has produced distortion of the striations with no evidence of extension into the muscle planes or the axilla (Fig. 15).

Pathological study after radical operation shows an adenocarcinoma without evidence of malignant invasion of the lymph nodes (Fig. 16).

Warren[16] has been able to show a diagnostic accuracy of from 85–95 per cent by the roentgen examination, and as evidence accumulates this percentage may be increased. Roentgenograms may be obtained of any breast and roentgenography has none of the physical limitations that makes transillumination unsatisfactory in some cases, as it is impossible to differentiate a malignant solid tumor from a non-malignant one by transillumination alone. The roentgen examination offers a high degree of accuracy in diagnosis, a permanent record of the findings, and a means for the serial study of changes in the breast, the extent of the malignant involvement can be determined and therapeutic measures guided accordingly.

The roentgen examination is not offered as a substitute for other methods but as a valuable and accurate addition to the present methods for the recognition of cancer as well as other diseases of the breast.

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ACCESSORY ARTICULAR PROCESS OF THE LUMBAR VERTEBRAE AND ITS DIFFERENTIATION FROM FRACTURE*

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WHILE discussing misinterpretations of vertebral roentgenograms at a meeting of the German Roentgen Society (April, 1931) Grashey called attention to certain non-traumatic fissures of the articular processes of the lumbar spine, a finding which may be mistaken for a fracture. Later in the same year Müller and Reisner each described a similar case in the German literature.

In Müller's article entitled "Gap formation of the articular and spinous processes of the vertebrae, explained on the basis of 'Umbauzonen' " he presents a roentgenogram of the second lumbar vertebra of a man who had a fall four weeks previously. A fissure is seen near the tip of one of the lower articular processes. He explains the phenomenon as "Umbauzone" and considers other causes as most unlikely. "Umbauzonen" are areas in which there have occurred increased bone absorption and replacement by connective tissue due to traction of muscles and ligaments. A few months later, however, the author changed his opinion concerning the causation of the finding and now feels that it is a congenital formation rather than an "Umbauzone." This latter view is expressed in an article, "Concerning a remarkable kind of anomaly of the spine. (Complete absence of articular processes.)" On this occasion he also describes a case in which the tip of one of the lower articular processes was absent.

Reisner, in his article, "How to distinguish normal, inflammatory and post-traumatic conditions of the spine," presents the diagram of a gap formation of one of the lower articular processes of the second lumbar vertebra in a man, aged forty, without history of trauma. He regards the fissure formation as due to the occurrence of an accessory bone.

The two cases of the German authors are the only ones thus far found in the literature.

Our interest in the matter was aroused several years ago by the observation of a similar case, which came to the attention of one of us (Rendich). Since then 4 more instances have been found, so that today we are able to add 5 of our own cases to the 2 already described.

Figures 1–5 demonstrate the presence of a fissure within certain of the lower articular processes of the lumbar vertebrae. This fissure, about 0.5 mm. wide, extends transversely and completely through the process at a level approximately 1 cm. above the tip. The borders of the bones entering into

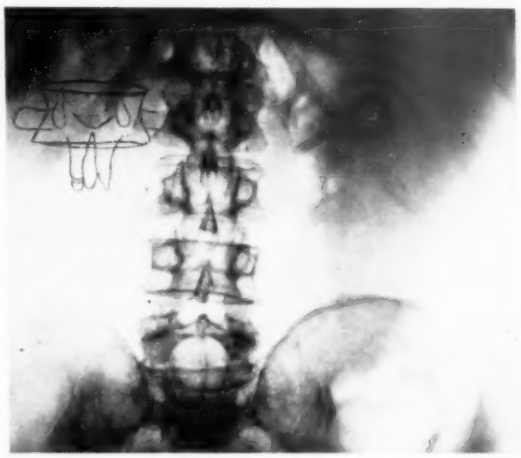

FIG. 1. Case 1. Male, aged sixty-seven, policeman. Diagnosis: Bladder stone. No history of trauma to spine. No pain.

Separate ossicle at tip of right lower articular process second lumbar vertebra; pointed appearance of its mate.

* From the Division of Radiology, Kings County Hospital, Department of Hospitals, New York City.

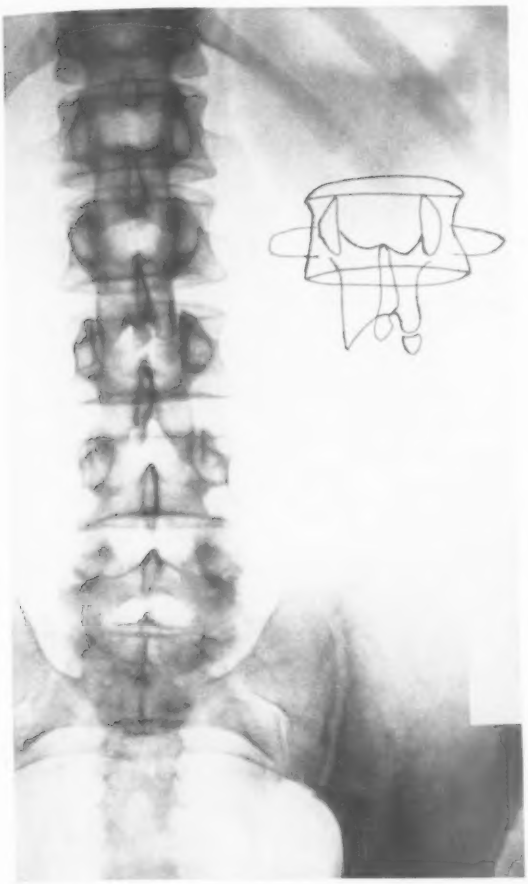

Fig. 2. Case II. Male, aged thirty, clerk. No history of injury, occasional pain in lumbar region for years, more severe recently, especially when lifting or bending.

Separate ossicle at tip of left lower articular process second lumbar vertebra; pointed appearance of its mate.

this formation are regular, well defined and of cortical density. This finding is noted in Figure 1 on the right side of the second lumbar vertebra, in Figure 2 on the left side of the second, in Figure 3 on the right side of the third, in Figure 4 on the left side of the third, and in Figure 5 on both sides of the third lumbar vertebra.

Limited data concerning sex, age, occupation, history, and clinical findings of the cases are furnished in the legend of each illustration. Whereas 2 patients (Cases III and V) had accidents just prior to the examination, the other 3 (Cases I, II and IV) fail to give any history of old or recent trauma. The roentgenographic examinations in these cases were requested with the object of studying the urinary tract (Cases I and IV) and on account of an occasional backache of long standing (Case II).

Endeavoring to explain the roentgenographic finding in our 5 cases we have considered four possible causes: (1) recent fracture, (2) old fracture with ununited fragments, (3) ununited epiphysis and (4) accessory bone.

A recent fracture may be readily excluded in view of the well-defined, regular borders of cortical density of the involved bones. Old fractures which have remained ununited may assume the appearance described. Yet 3 of these cases lack any history of trauma whatsoever (Cases I, II and IV), and 2 others (Cases III and V) sustained their only injuries but a few hours prior to roentgenography. These facts preclude the assumption of old fracture, thus eliminating trauma as a causative factor. The ab-

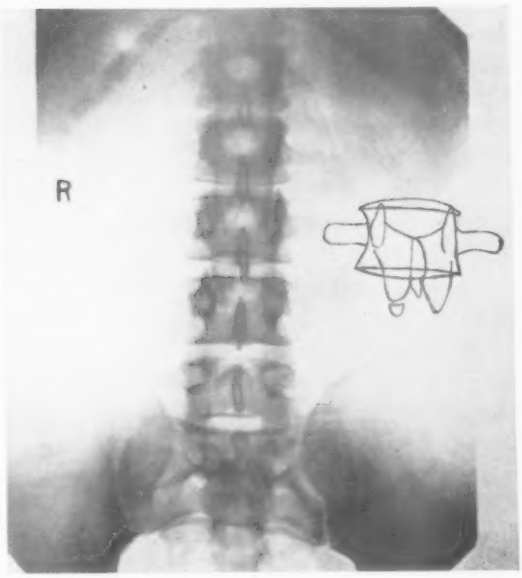

Fig. 3. Case III. Male, aged nineteen. Injury day of examination. Something snapped in back while he was pulling hand truck. No previous injury. Complaint: pain both sacroiliac regions, more on the left.

Separate ossicle at tip of right lower articular process third lumbar vertebra.

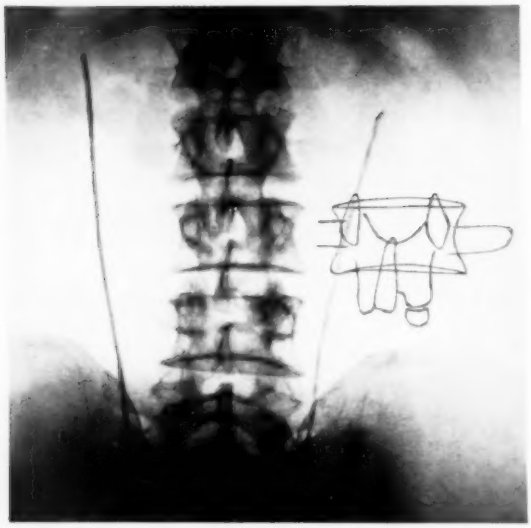

FIG. 4. Case IV. Male, aged sixty-one, clerk. Diagnosis: Manic-depressive. No history obtainable. Roentgen examination of urinary tract on account of confused complaints of urinary trouble.

Separate ossicle at tip of left lower articular process third lumbar vertebra. Note convexity at end of lower articular process and concavity at upper surface of accessory bone.

sence of displacement, the absence of any distinctly localized pain coincident with the fissure, and the symmetry of the findings in Case V further tend to exclude the possibility of fracture.

Since no epiphysis is known to exist for the development of the articular process tips, our finding can hardly be explained as an ununited epiphysis.

The classification of this separate bone particle as an accessory ossicle appears most logical. Such supernumerary ossicles articulating with and actually replacing a part of a major bone are not infrequently observed elsewhere in the skeleton. As an example may be mentioned the os trigonum representing the posterior lip of the astragalus. It is our opinion that the condition presented herewith is another member of the family of accessory ossicles. For these reasons, the name accessory articular process (processus accessorius articularis) is suggested.

From the study of these cases it seems most improbable that the gap formation due to the presence of an accessory bone gives rise to symptoms or impaired function. It further seems unlikely that this form of anomaly was referred to when Willis writing on vertebral anomalies made the following statement: "Defective articular processes threaten bony stability of the spinal column, predisposing to ligamentous injury or sprain with resulting local tenderness, muscle spasm, pain on certain motions only, and a history suggesting injury." We are of the opinion that the presence of this accessory bone has no bearing on the wellbeing of the individual. Its importance lies in the fact that it may be mistaken for fracture. Given a history of previ-

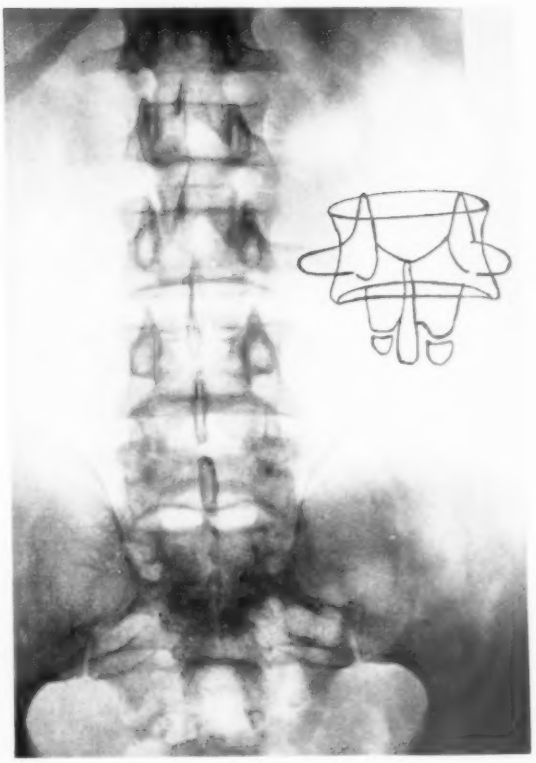

FIG. 5. Case V. Male, adult, laborer. History: A few hours prior to roentgen examination a pile of blocks fell on patient causing him to fall to the ground. Findings: Pain on active motion of lumbar muscles, rigidity of left lumbar muscles, tenderness of last dorsal and first lumbar processes. Clinical opinion: Contusion of back.

Separate ossicles at tips of both lower articular processes third lumbar vertebra.

ous back-trauma with complaint localized about this area and a finding as described above, one can readily imagine that it would require considerable diagnostic skill to decide whether an old fracture or an accessory bone is the explanation of the roentgen finding. If, however, it can be proved that the fissure existed prior to the injury and the onset of complaint, the decision against fracture in favor of developmental anomaly becomes certain. This finding again proves the desirability of roentgenographing the vertebrae of applicants for hazardous positions. Without roentgenograms made prior to injury demonstrating such a fissure it may be difficult to convince a claimant or jury, after injury, of the non-traumatic nature of the condition. This presentation furthermore emphasizes the importance of knowledge of the variations of the spine in order to distinguish developmental deviations from actual injury.

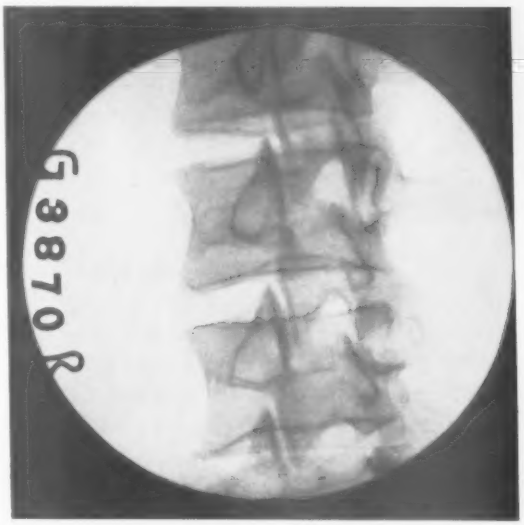

Fig. 7. Forty-five degree angle, oblique position. This view was recently developed for special demonstration of articular processes after the cases reported had been observed.

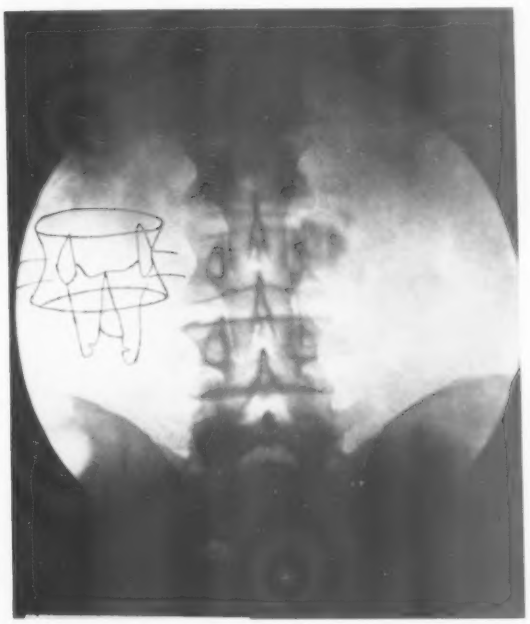

Fig. 6. Case vi. Male, laborer. History: Pulling on rope lost balance and fell four days prior to roentgen examination. Findings: Severe pain over lumbar muscles. Flexion and extension are painful. Some spasticity of lumbar muscles. Clinical opinion: Sprain of lumbar muscles.

Notches at lower ends of right and left lower articular processes third lumbar vertebra

While fractures of the articular processes may accompany other spine fractures, isolated fractures of the articular processes are comparatively rare, at least the publications on such fractures are very few. Within the last ten years only one such case could be found. This case was reported by Koch. The articular processes of the left articulation between the fourth and fifth lumbar vertebrae show transverse fractures. The upper fracture line is situated about 1 cm. above the tip of the lower articular process, the lower fracture line runs through the base of the upper articular process. Irregular appearance of the fracture lines and displacement of the fragments distinguish this case beyond doubt from the developmental anomalies just described. An adequate history and localized tenderness were also present.

In this connection it may be mentioned that considerable variation can be observed in the shape of these articular processes. One can see articular processes with a rather small base tapering off into an apex (e.g., the mates of the abnor-

mal articular processes in Figs. 1 and 2), and again processes of broad shape being practically the same width throughout.

Another variation is illustrated in Figure 6. About 0.5 cm. above the tip, notches are seen bilaterally at the medial aspect of the lower articular processes of the third lumbar vertebra. These notches apparently represent incomplete fissures.

To demonstrate the described ossicle the routine anteroposterior views taken on the Potter-Bucky diaphragm will usually suffice. Stereoscopic examination and oblique views serve to bring out the articular processes more distinctly, but are not indispensable (see Fig. 7).

It is interesting to note that all these anomalies—in our own as well as in the cases reported in the German literature—are associated with either the second or the third lumbar vertebra, the second being involved in 5 instances and the third in 3; in only one case (Case v) has the fissure been found to be bilateral. All 7 cases occurred in males.

SUMMARY

A separate ossicle is described occurring at the lower end of the inferior articular process of the second and third lumbar vertebrae.

Five cases are added to the two already described.

Study suggests this to be analogous to an accessory ossicle.

The name "accessory articular process" is offered.

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Vol. XXIX, No. 2

MELORHEOSTOSIS LÉRI

REVIEW OF LITERATURE AND REPORT OF CASE*

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INTRODUCTION

LÉRI and Joanny[12] cited several distinctive features to characterize an unusual bone condition which they presented before the Medical Society of Paris, on July 7, 1922. Their patient, a woman of thirty-nine, had noted since the age of ten a bony deformity of her left hand, producing divergence of the index and middle fingers; she associated a limitation of motion of her left forearm to a fall when she was seventeen, and she had been annoyed with a dull, almost constant, but especially nocturnal type of pain in her left shoulder since the age of thirty-one. Clinical examination revealed deformities throughout the length of her left upper extremity, with limitation of motion in several of the joints. There was no involvement elsewhere in her body. The roentgenographic manifestations were remarkable because of: the peculiar distribution of the new bone formations—their limitation not only to certain of the bones of the extremity, but even to definite portions of the involved bones; the apparent alinement of this smattering of processes; the distinct borders between the pathological and the normal portions of the bone; the great irregularity in the contour of the processes, and the apparent activity through the cortical depths regional to the lesions. The complexity of these characteristics prompted Léri and Joanny simply to consider the condition a hyperostosis "en coulée"—a flowing hyperostosis, presenting the appearance of a "coulée de bougie"—a candle-flow streaming itself for the entire length of the extremity. It did not fit into any recognized classification. Subject to further study, they thought it to be a developmental defect, but to indicate its essential characteristics, a flowing hyperostosis involving an entire extremity, they decided to call it "melorheostosis" (μέλος member ῥέω flow).

A similar case was reported in 1925 by Lewin and MacLeod.[17] Their patient was a man of thirty-five, who dated his first signs of trouble from the age of six, when he had noted swellings of two of his fingers. Shortly thereafter bony thickenings appeared in the region of the elbow. Periodic pains began about the age of ten. Deformity and limitation of motion gradually increased. Roentgenograms showed bone pathology along the outer aspect of the ulna, the cuneiform and pisiform, the unciform, 4th and 5th metacarpals, and the phalanges of the 4th and 5th digits. Notation was made of "increased bony production, sclerosis, eburnation, almost complete disappearance of the medulla, and obliteration of the cortical outlines." In this case, also, no definite etiological background presented itself, though the observers were struck with "distribution suggesting that of the ulnar nerve." They called the condition an osteosclerosis, adding that they would "appreciate assistance in classifying."

In 1926, Muzii[21] reported this type of bone involvement in the case of a ten year old girl. Apparently her trouble began about the age of five, when swelling of the left knee had been noted. The superior ramus of the pubis, the rim of the acetabulum, the head of the femur, inner aspect of its shaft, its internal condyle, the patella, tibia, astragalus, and all the bones along the inner half of the foot, including the great toe, showed discrete localized proc-

* From the Department of Roentgenology, Army Medical School, Washington, D. C. Published with permission of the Surgeon General of the Army who is not responsible for any of the opinions expressed herein.

esses. The left lower extremity was shorter than the right. Muzii did not attempt to classify his case. He was not impressed with any etiological factors, but mentioned the coincidental finding, in the skull, of an ossification of the coronal sutures. These were conspicuous by depressed interdigitations. His case, then, had an associated "craniostenosis."

The fourth record of this condition seems to have been Putti's case,[26] reported in 1927. The patient was a girl of eight, whose mother had noted a pes valgus, left, when the child was eleven months old; her first complaints of pain in the extremity were at the age of seven. There was relative shortening of the left leg, and a slight bowing—a genu valgum, with 4 cm. increase in the circumference of the knee. The condensations occurred from the lip of the acetabulum, downward, missing the head and neck of the femur, involving the greater trochanter and the lateral portion of the shaft and external condyle of the femur, leaving the knee joint intact, continuing over the lateral aspect of the tibia, the astragalus and regional portion of the calcaneus, to terminate with involvement of the third cuneiform. A biopsy was obtained from a site of condensation in the lower portion of the femur. Essentially, Putti's interpretations were: increased vascular pattern, conspicuous obliterations of the vessel lumina, perivascular ossifications, and atrophic marrow (showing few osteoblasts and many osteoclasts). His impressions were based upon the appearance of the newly developed osseous tissue. He saw a scattering of cells, many normal in outline, but the majority degenerating. He believed that the vascular obliterations were probably based upon local sympathetic contractions, and had preceded the osteogenic changes. This tissue was referred to Policard of Lyons, whose interpretations differed somewhat. He considered that a degenerative process was primary and that the condensations were secondary (the vascular obliterations occurring coincidentally). As no basic etiological cause could be established, Putti called the condition "l'osteosi eburneizzante monomelica" to emphasize pointedly the fundamental bony structure of the lesion and its involvement of a single extremity.

During this same year, two other cases were reported: the first by Zimmer,[32] and the second by Meda[18] (reporting Perussia's case). Zimmer's case, a man of thirty-two with involvement of the left lower extremity, showed condensations about the lip of the acetabulum, the head, neck, greater trochanter and lateral portion of the femoral shaft, its external condyle, the fibula, astragalus, calcaneus and cuboid, the external portion of the scaphoid, the third cuneiform, and the third and fourth metatarsals with their corresponding phalanges —again a mottled alinement of bony processes. He believed the condition to be based upon a congenital developmental defect. Kauffmann[8] reported on a biopsy taken from this case. He was unable to draw any conclusions, but noted: compact trabeculations, normally outlined Haversian canals, and a fibrosed marrow containing active osteoblastic islands.

Perussia's case was reported in considering characteristics differentiating Paget's disease. In that case, Meda described condensations along the lateral aspect of the lower portion of the humerus, the entire radius, the middle carpals, the 2nd, 3rd and 4th metacarpals and the phalanges of the index, middle and ring fingers. There was deformity and limitation in motion of several of the joints.

Valentin[30] reported the seventh case. In it the distribution of hyperostosis was similar to the first case reported by Léri: a seventeen year old girl, showing condensations from the glenoid cavity to the terminal phalanx of the right index finger. In the humerus there was encroachment upon the medullary canal. There was limitation of motion in the elbow, wrist, and index finger, and there was conspicuous divergence of the index, from the middle finger, as noted in Léri's case. Measurements showed 3 cm. shortening of the extremity and 2 cm.

less circumference of the right forearm versus the left. The history suggested the beginning of these lesions about the age of two.

By this time, Léri had studied his case for six years. Very interestingly, during the interim, there had developed two new bony masses; one in the depths of the infraspinatus muscle and the other regional to and seemingly attached to the second rib. The mass within the muscle was removed and studied. It appeared as normal bone, containing Haversian canals and a cellular marrow. There were many osteoblasts and few osteoclasts. The vessels were patent and appeared normal. Moreover, there were a number of irregularly outlined cartilaginous islands. Léri was not impressed as to any evidence of perivascular condensations, as suggested by Putti. There was a conspicuous vascular proliferation and active ossification. In summing up his studies of these six years, he emphasized the following characteristics of this bone condition: early onset of involvement, usually between the ages of five and twenty; incipient development of the processes; transient accompaniment of pain (this usually dull in character and often unnoticed for years unless aggravated by pressure or prolonged activity); but above all, the eventual linear distribution of irregularly contoured condensations extending for the entire, or almost the entire, length of one extremity. The additional observation of detached bone islands prompted Léri and Lièvre[13,14,15] to change their original opinion as to etiology. They had first considered that the basis was a developmental defect, but were now led to believe in an "affection parasitaires," and they offered the hypothesis that the infectious agent might release osteoblastic cells, thereby explaining the embolic dissemination which they thought to be the means of origin of the bone islands.

Meisels reported the eighth case.[19,20,21,22] It was typical in appearance, with involvement of the right lower extremity in a twenty-five year old woman. Several features of the case were stressed: the damp marshy character of the patient's residence (which suggested to Meisels a possible association of malaria—though clinically his patient was negative); the selectivity as to site of involvement; its linear distribution, leaving certain parts of the bone intact (in this case the distal epiphysis of the femur, the knee joint and the upper two-thirds of the fibula); and the complete sparing of certain bones, especially at levels of duplication (in this case the tibia showed no involvement). In considering the several cases mentioned, Meisels was led to believe that when the epiphyseal-metaphyseal junction becomes involved previous to the completion of ossification there results diminished growth—explaining the relative shortening of the involved extremities in the cases of Muzii and Putti; when excessive condensation and overproduction of osseous tissue occurs after the growth stage has been completed, there may result mechanical locking of joints, and even mechanical bowing of bone.

Goldschlag[5] discussed this same case. He was impressed with the associated "trophedema," and suggested the possibility of an endocrine background. This patient presented evidence of hyperfunction of the thyroid and hypofunction of the pituitary.

Léri, Loiseleur and Lièvre[16] reported another case, apparently the ninth recorded in the literature. This case simulated the first one reported by Léri and Joanny as to distribution of lesions; the right upper extremity showed condensations and eburnations extending from the scapula to the ends of the second and third digits. There was the characteristic alinement, the characteristic sparing of parts of bone, and the entirety of certain bones (here the radius versus the ulna). This was the case of a thirty-nine year old cleric. A stiffness of the middle finger had been noted since infancy. Sharp lancinating pains of the wrist and hand had bothered him more recently. It is interesting that for the past ten years he had been treated along the lines of antisyphilitic drugs, three or four series of sul-

pharsphenamine and bismuth having been routinely given. Except for a possible relief of some of the pain, no effects were noted; the limitation in motion remained. The pains were intermittent, seemingly worse at night, entirely absent during warm weather. A section from the third metacarpal was obtained. Bacteriological studies were negative. Microscopically the findings were: condensation predominant over rarefaction; irregular rearrangement of osseous layers about Haversian canals; distortion and confusion of bone pattern; increased osseous density with proportionate decrease in the number and size of the Haversian canals—where condensation was conspicuous; absence of osteoclasts where rarefaction was paramount; the absence of inflammatory changes (except for a possible degree of edema in the soft tissues); the absence of newly formed vessels (in procuring this tissue there was a noticeable lack of oozing). These observations left the impression of "une resorption de l'os preëxistant avec formation de tissu osseux nouveau beaucoup plus compact." The nature of this initial bone resorption and subsequent dense ossification remained unsolved. A small portion of this tissue was transplanted subperiosteally to the femur of a monkey. This graft was studied and absorption confirmed roentgenographically at the end of eight months. Apparently no other local reaction occurred.

Kemkes[9] reported the case of a fifty-four year old machinist. There were lesions on the right scapula, the outer aspect of the humerus, and following true to form, along the radius, the outer carpals, the first and second metacarpals and the phalanges of the thumb and index finger. There was considerable locking of joints by hyperostotic processes. The muscles of the arm showed atrophy and there was some loss in the superficial sensations. This case is of special interest because of the age of the patient (the earliest recollection of symptoms was at about the age of forty-two). As for etiology, in this case Kemkes was inclined to favor the Zimmer theory—a congenital hyperostotic bone condition.

Junghagen's patient also showed involvement of the upper extremity.[6] There were lesions extending from the scapula to the tip of the third finger. Again the patient was healthy in appearance, a farmer, giving a history which seemed to date the onset of lesions back to his childhood when he had had much trouble in the way of "rheumatic" pains. More recently he had developed limitations in muscular strength and stiffness of the joints in the one extremity. The roentgenograms presented the characteristic distribution of processes —that unique flow of lesions, sparing parts of bones and the entirety of certain bones. In many places the spongy portions were seen invaded or obliterated. A biopsy was obtained from the olecranon process. Microscopically it presented the pattern of eburnation; the lamellae, for the most part, were compact with no uniformity of design—trabeculations meeting at various angles; a paucity of either osteoblasts or osteoclasts as if the process were old and completed; very narrow Haversian canals; few but normal-appearing blood vessels; and in general the absence of any signs of inflammatory irritation. Junghagen stressed the following considerations as to etiology: (1) The slow development of the processes, their limitation to a single extremity, the negative blood picture (both as to cells and Wassermann reaction), all contradict the possibility of these lesions being organic in nature (either tumor, syphilis, Sternberg's disease, leucemias, etc.). (2) The appearance of the lesions suggest considerations of atypical osteosclerosis (Albers-Schönberg), or of Paget's disease, but the distribution is characteristic of neither. (3) The local ischemia theory of Putti and likewise the neurogenic theory of Lewin and MacLeod cannot be applied to all cases reported. By this process of elimination there seemed to remain only the theory suggested by Zimmer. This theory appeared rational because of the very slow development of the condensations which seemed comparable to the rate

in the growth of normal bone. The joint troubles, developing later, he explained on the basis of exostoses and superimposed changes of the ordinary arthritic variety.

Piergrossi,[25] in 1931, reported a very complete distribution of lesions along the right lower extremity of a thirty-six year old male. The lower portions of the ilium, ischium and pubis, as well as the acetabular regions, were massively involved, the outer aspect of the femur, less so; the fibula dense and bowed; the lateral tarsals, metatarsals and phalanges showed a smattering of lesions. History of the case added little: a severe whipping at the age of fourteen; a crushing injury of the leg and ankle at eighteen. There were no severe pains to be definitely associated until recent years, although deformity was noted for about fifteen years (he was discharged from the Service during the war because of this). The hip and knee motions were limited—roentgenographically a mechanical type of ankylosing. The following differential considerations were made: Osteopetrosis (Albers-Schönberg); osteopoikilosis (disseminated bone islands); osteoplastic carcinomatous metastases; chronic osteomyelitis; Paget's disease; von Recklinghausen's disease; congenital and acquired luetic osteites; and progressive ossifying hyperplasia of the fascia or of the muscle. Piergrossi considered the possibility of developmental defects, but after comprehensive study of the various theories, he favored the local ischemia theory of Putti—a status sympathicus. He considered two stages in the development of these lesions: (1) a simple sclerosis of bone, and (2) a subsequent periostosis (producing the abundant osseous overlay).

Rokhlin[28] reported a case showing much less involvement, but otherwise the characteristics of the condition. There were lesions of the internal condyle of the humerus, the ulna, the capitate and the 2nd and 3rd phalanges of the middle finger. Though the lesions were few and widely separated, the essential features of melorheostosis—alinement of discrete hyperostotic lesions and interruptions of normal-appearing bone along the path—were conspicuous.

Weil and Weismann-Netter,[31] in a "consultation du rheumatisme," reported a case which again resembled Léri's first case. The volvement was of the upper extremity in in a man of thirty-seven, an officer of the French army during the World War. The bone aches were masked by several other conditions: "repeated polyarthritis, pulmonary tuberculosis, malaria and traumata". The distribution of the lesions in this case was of particular interest because of the fact that though there was involvement of the humerus and some of the carpals, metacarpals and phalanges, both the radius and the ulna were entirely spared. Moreover, this case was unusual for the lesions crossed beyond the limits of the extremity to involve the fourth rib (throughout its entire length, "including its vertebral insertion"). Because of this latter consideration these observers suggested that the term "rhéostéose" might be more appropriate.

Recent interest in this subject in the United States has been stimulated by Kraft.[10] He reported two cases, a forty year old male showing involvement of the left upper extremity, and a thirty year old female with lesions in the right lower extremity. The history of the first case presents a series of notations indicating a progressive development of the lesions subsequent to the age of twenty-one: a hard nodule on the radial side of the left wrist at that time; a palpable lump under the left clavicle, at twenty-two; an uneven thickness of the index finger, at thirty; enlargement of the humerus, at thirty-three; nodular enlargement of the thumb, at thirty-six; parasthesias and signs of nerve and muscle weakness during the past three years (since thirty-seven). The physical and roentgen manifestations were characteristic. The remarkable findings were irregular masses of bony material in the soft tissues about the left shoulder. For the most part, these masses appeared as spurs

projecting from regional bone, but there was one which projected from the costochondral junction of the first rib—well removed from the extremity. Varying degrees of decalcification were noted. Developmental disturbance was suggested in that there was a slight amount of curvature of the bones of the right forearm (uninvolved by these lesions). The second case presents interest from several standpoints: it had previously been diagnosed as an ossifying periostitis;[3] the history again dated the onset of trouble subsequent to the age of twenty-one. This patient had had slight pain and discomfort in the right hip when twenty-three, which after excellent study had been diagnosed as "osteomyelitis." At that time her white count was 14,000. Though no surgical drainage was done, she was shortly able to carry on with no other disturbance than slight limitation in the motion of the hip. Annoying pain developed about seven years later. Hyperostotic involvement was limited to the acetabular regions and the femur. Kraft, referring to the embryological studies of Harrison, Byrnes, and Mangold, questioned the application of the developmental theory of Zimmer, and favored endocrine consideration (until more definite etiology was established). He suggested the possibility of value in roentgen therapy.

These are the 16 cases, distinctly similar in appearance, reported in the literature of France, the United States, Italy, Germany, Switzerland, and Russia.* There are reports of cases† closely simulating these, in some cases bearing the same diagnosis, but until more is known of this condition they do not seem to fit into this category. This does not necessarily mean that the condition is so very rare. The symptoms are only slightly disturbing and seldom have the patients sought medical care in the early stages. Diagnosis has been established roentgenologically, and as that adjunct has not been so universally available, it is quite likely that many cases have been treated without thorough knowledge as to deep-seated lesions.

Comprehensive discussions on this subject have been written by Lazzarini;[11] Comby;[1] and Geschickter and Copeland.[4]

CASE REPORT

J. L. R., male, aged thirty-eight, married, carpenter, entered the hospital for roentgen therapy, having a transfer diagnosis of "Paget's disease."

Family History. Essentially negative. Of German and Welsh descent.

Past History. From the age of birth until twenty-two he resided at his home in Washington, D. C., and Virginia; ten years' schooling, steamfitter's apprentice and steamfitter. From the age of twenty-two to twenty-four he served in the Army, eighteen months in France; Motor Transport Service; truck driver, dispatcher and shopworker. From the age of twenty-five to twenty-seven he lived in Washington, D. C., working as a steamfitter, and from twenty-seven to thirty-eight he lived in Washington, D. C., and Virginia, working as a carpenter.

Diseases. Measles, chickenpox and whooping cough as a child; malaria, ages fourteen, sixteen and seventeen—quinine therapy; influenza at the age of twenty-four. Venereal signs and symptoms denied.

Marital History. Married at the age of twenty-six; wife living and well; 2 children living and well.

Present Complaint. The patient claimed that his trouble began with swellings of both feet and ankles, and dull achings over the sides of both feet and upward into either calf. This was first noted at the age of twenty-two, while digging ditches in France. After about a week of that duty his legs throbbed so much that he had to be relieved and was given office work. His arches and ankles were supported by adhesive strappings which were applied weekly for about four months. This gave him much relief. At the time of his discharge from the service he was rated as 10 per cent disabled because of flat feet. He continued his former trade as a steamfitter, but the pains in his legs became so severe that after two years (age 26) he changed his occupation to carpentering. He claimed this latter occupation required less agility, but that he continued to have so much trouble with his feet

* Since compilation of these cases during the early part of 1932, Saupe's case[28a] has been reported.

† Included as truly infectious lesions, or variants of this condition, the reports of Sicard, Gally and Haguenau[29]; Froelich[2]; Rendu and Gay[27]; Kahlstorf[7]; and Milani.[23]

and the use of his left leg that he averaged only about four days' work a week. Besides the dull aching previously noted, there progressed, intermittently, sharp lancinating pains in his left upper thigh. These pains were aggravated by exertion, at first only of a physical nature, but recently also by way of mental anxieties. Several times a year he recieved physiotherapy and allied forms of medical care. Roentgenograms taken in December, 1922* (patient's age then 27) revealed "marked increased density of bone in the region of the greater trochanter of the left femur. Spine and hip joints negative." The severity of these pains continued and seemingly became "unbearable" during the past three years. He is now unable to maintain any one position for any length of time; claims he cannot sit through a movie performance, for he says the pains seem to begin both because of the

Fig. 1. Note the wasting of muscles in the posterolateral aspect of the left thigh and leg, the bilateral pes planus and the small plexus of the popliteal varicosities.

Fig. 2. Anteroposterior projection of left lower extremity. Note the alinement of hyperostotic processes following the lateral line of the extremity, the disseminated erosions on the surface of the external condyle, the sparing of the joint and the inward bowing of the fibula.

* Due to transportation of records and films and the effects of the elements, these particular reports were confirmed and the films destroyed in 1925.

FIG. 3. Lateral projection of the left lower extremity. Compare with Figure 2, noting the localization of some of the condensations in the medullary canal, upper half of the femur. Note also the marked posterior bowing of the fibula, and the flecking condensations of the astragalus and calcaneus.

sitting posture and because of mental anxieties. Weakness in the muscles of the extremity has increased so that for the past year he has found it necessary to use a cane.

Physical Examination. Weight 172 pounds, well developed and nourished, active and seemingly agile except for a slight limp toward his left side. Temperature, pulse, and respirations normal. General physical examination essentially negative, blood pressure, 130/85; moderate bilateral increase in tendon reflexes. Positive findings confined to the left lower extremity: painful motion of the thigh, no limitation, but difficulty in complete flexion of either the thigh or knee; inability to rise from a squatting position without help; visible lateral prominence, upper third of thigh; moderate wasting of the biceps femoris, gastrocnemius and solius groups; slight varicosities popliteal region, marked flattening of both the longitudinal and transverse arches of the foot. Comparative measurements:

	Right	*Left*
Anterior superior spine to mid-patellar level	19 1/2 inches	19 1/2 inches
Anterior superior spine to internal malleolus	35	35
Circumference, mid-thigh (comparative measurements made from anterior superior spine)	22	21 1/2
Circumference of knee	15	15
Circumference of calf (9 1/2 inches above internal malleolus)	14	13 3/4

Laboratory Findings. Urine and fecal examinations and blood counts negative. Four provocative Wassermann and Kahn determinations negative. Four blood smears negative for malaria; basal metabolic rate minus 24; blood calcium 7.15 mg. on one occasion, 9.4 mg. ten days later, with urinary calciums of 398 and 298 mg. per 24 hours, respectively; the serum phosphorus values corresponding to the above were: 2.6 and 2.7 mg. per 100 c.c., and the respective 24 hour urine output of phosphorus was 1297 and 1459. There was no medication nor dietary treatment during this interval.

Roentgen Findings. A complete skeletal study was made. The findings were negative except for the manifestations in the left lower extremity.

Femur. The left femur, compared with the right, shows an anterolateral bowing to the extent of 0.8 cm. deviation at its mid-length. Beginning at the lateral aspect of the head, there extends almost vertically downward a conspicuous condensation which includes the lateral half of the neck, the mesial aspect of the greater trochanter, and the lateral aspect of the entire

shaft. Distal to the greater trochanter this condensation appears to be of the nature of a piling up of dense bony substance. At the mid-length of the shaft this piling up process attains a thickness of 3 cm., which is approximately the same as the diameter of the shaft itself as visualized at that level. At the level of the lesser trochanter there extends downward, apparently from the inner levels of the cortex, a condensation which encroaches upon the medullary canal for a distance of 7.5 cm. At the mid-length of the shaft, there is a single irregular mass of condensation, measuring 1 cm. in its greatest diameter, which is situated in the medullary portion. (The location of these lesions as being medullary was verified both by anteroposterior and lateral stereoscopic views.) There is no regularity in the pattern of this condensing substance, though there is apparent tendency toward lamellation parallel to the shaft. There appears to be no cortical involvement of the inner and anterior three-fourths, at any level. The posterolateral portion of the lateral condyle presents a moth-eaten appearance. Careful study compels the impression that there are disseminated superficial erosions, some appearing as discrete punched out excavations, others showing irregular continuity as of a branched etching. There is a small area, subcortically located, where a degree of rarefaction is conspicuous. These lesions are outlined by condensations of their borders. In many places these condensations appear simply as intensifications of the normal trabeculation lines; in others, where the condensations are more densely piled up, there is a peripheral fading-out into the normal lines.

Knee Joint. The margins are distinct and regular; there is no widening of the joint space.

Patella. No signs of involvement.

Tibia. No signs of involvement.

Fibula. There is posteromedial bowing of the fibula to the extent that in the true anteroposterior projection, its inner border appears parallel and only about 2 mm. lateral to the lateral border of the tibia; in lateral projection the bowing is conspicuously posterior, effecting a 1 cm. flare of its mid-length. The same type of condensation, seemingly arising in the trabeculation lines of the cortex, extends from the internal aspect of the head, along the internal and posterior portions of the upper fourth, enveloping in its downward progression so as to surround the middle half of the bone where it almost completely masks the medullary outline. The external malleolus presents a slight degree of central rarefaction; on the periphery, there is a moderate degree of condensation both in the region of its articulation with the tibia and at the very tip of the process.

Bones of Foot and Ankle. There is a flecking of condensation in the region of the os trigonum which seems to intensify its union with the calcaneus. Extending forward on either side, the lines of condensation fade out with the trabeculations of the calcaneus and also of the very posterior periphery of the astragalus. The remaining tarsals, the metatarsals, and all the phalanges appear normal.

Summary. The characteristics of this case are unique. The patient, a man of thirty-eight, appears to be in the optimum of good health. He is well nourished, mentally alert, and physically well developed. His gait is restrained only by a slight limp toward the left side. He complains of sharp lancinating pains occurring periodically in his left hip; claims these are aggravated by physical exertion, and recently even by mental anxieties. There was no definite date as to the onset, just an insidious progressive development, probably conspicuously sensed about the age of twenty-six. The recent progress of the condition has been alarming because of increased weakness and limitation of motion in the one extremity. There is evident wasting of the muscles along the posterior and lateral aspects of the thigh and leg. The femur is prominent, with palpable roughening of its upper third. There is a small plexus of varicosities in the popliteal region. The arches of both feet are markedly flattened. The roentgen manifestations of the left lower extremity are striking: essentially an interrupted but well-alined series of lesions extending from the greater trochanter to the calcaneus. There is an area of multiple erosions of the cortex. Here the lesions appear as disseminated osteites. Included are minute clear-cut, punched-out lesions, and gradations from such to more shallow excavations where the walls show conspicuous condensations; some presenting the appearance of simple intensification of the trabeculations; others, as prolific laying-

down of new bone. Dense ossifications in other sites extend inwardly into the medullary regions, and peripherally well beyond the confines of the periosteum. Always there appears a selective involvement; linear segments of bone of large diameter; regional choice where there is duplication of skeletal support (in this case, the fibula versus the tibia,—that is true alinement following the involvement of the external condyle of the femur). There is lateral bowing of the femur, internal and posterior bowing of the fibula. The lesions extend to the very margins of the knee and ankle joints, yet the joint outlines are distinct and regular with no suggestion of widening of the synovial spaces. Except for the left lower extremity, the skeleton might be considered essentially negative. This is the picture of melorheostosis.

DISCUSSION

Again no etiological basis can be presented for this condition. These outstanding features can only prompt hypotheses. By the process of elimination, Junghagen and Zimmer have resorted to an explanation along the lines of developmental defect. Many features suggest that, but as Léri has pointed out, there does seem to be a distinct cellular reaction. Our roentgenograms manifest such in the region of the external condyle where there is the suggestion of an osteitis. With the absence of a general constitutional toxicity, the striking linear selectivity, and the absence of joint involvement, one cannot consider this osteitis to be of an infectious nature. One anatomical condition suggests itself—subperiosteal telangiectases. Could not their distribution be of this pattern? The etiology of telangiectatic plexuses might either be congenital or developmental. Telangiectasis is subject to petechial hemorrhage (consider the extravasations in purpura telangiectoides, there, subsequent to toxins, trauma, and probably also in response to allergic or endocrine conditions). Hemorrhage produces obliteration of regional channels; obliteration would excite progressive telangiectasis—thus a vicious circle. Cortical erosion and subsequent ossifications would be the sequence to such subperiosteal hemorrhages. Thus could be explained the diverse biopsy findings: the early stage of resolution as seen by Léri; the intermediate as seen by Putti; and the end-results as seen by Léri, Loiseleur and Lièvre (ninth case), Kauffmann, and Junghagen. There is contradiction as to direct endocrine relationship; the general skeletal study does not suggest a real deossification process as hinted by the blood and urine calcium and phosphorus analyses. These are included for collaboration with any subsequent findings. If the underlying condition truly be telangiectasis, we might consider, as did Kraft, the value of roentgen therapy.

Bowing of the femur, as well as of the fibula, prompts three considerations: (1) Undue strain for a hypoplastic type of bone,* (2) mechanical result by the leverage effect of hyperostotic processes,* and (3) unequal tension of opposing muscle groups. Contradicting the first: the above trabeculation pattern, presenting no compensatory ossification of lesser order, as in Paget's disease, appears instead to be a very dense eburnation which should possess even greater weight-bearing strength. The fact that there is insufficient eburnation regional to the articulations to effect leverage should dismiss the mechanical theory. Therefore, the last consideration seems most rational. The eburnations must certainly impinge upon muscle origins or insertions, thereby effecting a change in their contraction strengths. Clinically this is manifested by "progressive muscular weakness." That refers to voluntary tone, but the more constant unconscious tone must likewise be affected. Since the eburnations are unilateral, there would result an imbalance in the opposing muscle tensions, and bowing might be expected to result after a sufficiently long time.

The absence of history pointing to acute joint or bone involvement, in the early stages of this condition, seems to be a significant fact. There was a conspicuous sparing of the joints in all of the cases included in the above discussion. It seems easily

* This explanation has been offered by previous observers.

conceivable that other conditions such as arthritides or osteites of truly infectious nature (as described by Milani[23]) might slowly progress into a chronic ossifying periostitis. Such precursors are not characteristic in the cases included above, as reports of melorheostosis. Moreover, instead of a continuous hyperostotic process, these cases typically portray a series of truly alined processes which spare the joints (until very late), and which are disseminated in an interrupted pattern for the full length, or almost the full length, of a single extremity.

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THE DIFFERENTIAL DIAGNOSIS OF DISEASES OF THE LIVER AND SPLEEN BY THE AID OF ROENTGENOGRAPHY AFTER INTRAVENOUS INJECTION OF THOROTRAST (THORIUM DIOXIDE SOL)*

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UNTIL recently visualization of the liver and spleen by means of roentgenography was of little practical value. It was possible by flat roentgen plates of the abdomen in some cases to procure meager information as to the size and shape of the liver and rarely of the spleen. The production of pneumoperitoneum increased the value of this method. A great need has always been felt, however, for some method to give accurate information of the size, shape and structure of the liver and spleen. The diagnosis of diseases of the liver has been difficult because of (1) the relative lack of knowledge of such diseases, (2) the inability to determine any but severe grades of depression of liver function and (3) the failure of help from roentgenography. The latter shortcoming has apparently been definitely remedied.

HISTORY OF THE METHOD

In 1928 Radt,[10] at the University of Berlin, developed the method of injecting intravenously a colloidal material of sufficient atomic weight which, after being taken up by the reticulo-endothelial cells, allowed roentgenographic visualization of those organs containing the greatest quantity of these cells, in particular the liver and spleen. A thorium dioxide preparation called tordiol was first used in animals, but this solution was not stable and the danger of capillary embolus formation made it objectionable. Because of this property of tordiol, Oka[6] and later Radt made use of a somewhat similar preparation called thorium dioxide sol, which was found to be relatively harmless. Animals were apparently not affected by the injections after a period of two years, although much of the substance was still found in the tissues.

Ill effects were not observed in 20 patients injected with thorium dioxide sol by Radt and in 6 cases by Oka, except that in a few cases there was a slight transitory discomfort, mild tension of the limbs, chilly sensations and slight rise in temperature.

These investigators found the size and contour of the liver and spleen to be plainly visible, and in several cases they could determine the presence of metastatic carcinoma and cirrhosis of the liver.

ANIMAL EXPERIMENTATION

Considerable animal experimentation has been performed to determine the action and effects of thorium dioxide. After intravenous injections Kadrnka and Rossier[3] found granules with greenish reflections in the reticulo-endothelial cells of the spleen, liver, bone marrow and adrenal glands. These cells were globular, and the nucleus was displaced to the periphery of the cell. The larger the dose, the greater was the engorgement of the cells. The intensity of the roentgenographic shadow of the liver and spleen was decreased after a few months by about one-half. Elimination is apparently very slow and occurs mainly through the bile and urine, as indicated by the work of Leipert[5] and others. Lambin[4] studied the effect of the injections in rabbits upon the blood picture. Moderate doses produced an erythroblastic reaction, while large doses produced pronounced anemia, recovery from which was spontaneous. A phase of leucopenia followed the injections, but this

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changed to a longer phase of leucocytosis, first of granulocytes and later of monocytes. Popper and Klein,[9] in similar experiments, did not find changes in the blood picture of any importance. Thrombocytopenic purpura hemorrhagica was produced in several rabbits by Shih and Jung[13] with doses of thorotrast several times greater than those used in man. In this connection we made platelet counts before and after the injections in many of our patients and did not find significant changes. In general, it may be concluded that the effects of the injections are harmless.

Otell[7] has recently reviewed the subject of the effect of the injection of thorotrast upon the functions of the reticulo-endothelial system. Depression of function of these cells has not been definitely demonstrated by animal experimentation.

QUESTION OF RADIOACTIVITY OF THORIUM DIOXIDE

The statement has been made by Stewart, Einhorn and Illick[14] that thorium dioxide sol might become activated by roentgen radiation. We believe we have proved by experiments that this does not occur.* Gauze saturated with the medium was subjected to intensive roentgen irradiation, placed on a photographic film and kept in the dark for twelve hours. The film remained unaltered. Baumann and Schilling[1] performed like experiments with corresponding negative effect. Experiments of this kind were also performed by us with the organs of patients who had been injected during life with this medium, and the results were similar. Tests performed by Kadrnka, and for us by the U. S. Bureau of Standards at Washington, D. C., showed that the radioactivity of thorium dioxide sol is negligible.

In order to determine whether secondary radiation is induced in tissues saturated with thorium dioxide we subjected the liver of a patient, who during life had received several injections of thorotrast, to intensive roentgen irradiation and placed the organ on a photographic film for forty-eight hours in a dark room. Alteration of the film did not occur.

On the other hand, it is conceivable that in cases of leucemia the presence of a foreign substance of high atomic weight in the tissues might intensify the effect of radiation therapy by causing transient secondary radiation.

METHOD OF ADMINISTRATION

Most authors who have used thorium dioxide sol have further diluted it with glucose or salt solution. This apparently is unnecessary and we have not diluted the medium in any of our work. The contrast medium is a stabilized thorium dioxide sol, recently perfected by Kadrnka and sold under the trade name of thorotrast by the Heyden Chemical Co.* It contains 25 per cent of thorium dioxide sol (22 per cent thorium dioxide metal) in a glucose solution. It is opalescent, odorless and has the consistency of heavy oil. A homogeneous solution can be produced by dilution with normal saline up to 1:8. It may also be used for cystography, pyelography and arteriography.

In hepatosplenography 25 c.c. daily on three consecutive days is administered intravenously in adults of average size. In children the dose is reduced roughly in proportion to the weight. More accurate estimation of dosage on the basis of body weight is apparently unnecessary. In general, the density of the roentgen shadows of the liver and spleen depends upon the quantity of the medium administered and the anatomical and functional integrity of the cells that store it. If only the outlines of the liver and spleen are desired the dose may be reduced one-half. Fractional doses are used in order to eliminate the shock which might be produced by the injection of too large a dose of foreign material.

Films may be taken at any time after

* The question of the possibility of remote conversion of some of the metal to mesothorium or radiothorium has since been raised, however, but can only be answered by stating that neither animals nor patients have ever shown any evidence of this.

* The Heyden Chemical Company of New York furnished all of the thorium dioxide sol used in our series. They generously furnished sufficient medium for the test in 30 cases.

four hours following the last injection. On the night before the examination the patient is given the usual evening meal and at bedtime 8 grams of compound licorice powder. On the morning of the examination a cleansing enema is given and the patient is advised to come to the roentgen department without breakfast. Films are taken on the Potter-Bucky diaphragm with the patient in both the prone and supine positions. The tube is centered over the ensiform cartilage. The following technique has been used in patients of average physique: 60 kv. peak at 100 ma. for 3 1/2 seconds at 25 inch distance. It is well in large individuals in order to get a good image of the spleen and liver on the same film to place the film transversely. A more comprehensive idea of the structural characteristics of the liver and spleen is obtained by making several exposures within a range of 10 kv. of this dosage.

NORMAL APPEARANCE OF THE LIVER AND SPLEEN

In good films the liver should cast a homogeneous shadow of approximately the same density as the spine. Occasionally blood vessels in the liver are seen as dark branching lines, usually in the lower right portion of the liver shadow. The spleen normally has a density slightly less than that of the liver and about the same as that of the ribs. In some cases the kidneys are well visualized.

SIZE OF THE LIVER AND SPLEEN

In determining whether the liver and spleen are abnormal in size it is necessary to know what the average normal size of these organs is. We obtained very little help from the literature in this regard, and unfortunately a sufficient number of individuals without alteration of the liver and spleen has not been studied to form a basis for this comparison. The only work of any value in reference to the size of the liver is that of Pfahler,[8] who compiled tables of the size of the liver in subjects of both sexes, of different ages and of varying heights and weights. These data were computed from flat films of the abdomen. Pfahler found that there was very little variation in adults in the size of the liver determined roentgenographically. Two measurements of the liver shadow were taken; one was the "length" which was measured from the highest point of the upper border to the lowest border of the tip of the right lobe; the second measurement was made obliquely from the upper border to the lower border in a direction which gave the maximum measurement of the apparent thickness of the liver. The average normal length of the liver shadow was 21.3 cm., with limits of approximately 18 to 22 cm., and the average oblique measurement was 12.8 cm., with limits of approximately 10 to 14 cm. These data, while the best available, are obviously inaccurate because of the indistinctness of the liver shadow in such films. The measurements were only comparative, inasmuch as the short distance between the tube and its film (25 inches) produced some distortion.

Comparative determinations of the size of the spleen are still more difficult since the spleen normally varies a great deal in size from time to time. Also, in normal subjects after the injection of thorium dioxide sol the spleen is often not visualized because it is overshadowed by the left lobe of the liver and by gas in the stomach and colon. Even in cases of splenomegaly there may be some difficulty with this method in accurately determining the limits of the spleen for the same reasons. Nevertheless, after experience with the method one may be able to fairly accurately estimate the size of the spleen, and changes in the size of the spleen in the same individual may be followed. More work must be done with this method, however, to determine the normal variations in the size and shape of both the liver and the spleen.

STUDY OF CASES

Forty patients have been studied by us using this method.* In the ultimate analy-

* Since the writing of this paper we have used this method in as many more patients with excellent results and without apparent ill effects.

sis of these cases they were grouped according to diagnosis as follows: portal cirrhosis (4); atypical cirrhosis of liver (1); subacute hepatitis (3); syphilis of the liver (hepar lobatum) (2); Banti's disease (1); metastatic carcinoma of the liver (7); hepatoma (2); lymphatic leucemia (2); myeloid leucemia (1); purpura hemorrhagica, nonthrombocytopenic (1); passive congestion of the liver (3); tuberculous peritonitis (1); sepsis with large liver and spleen (1); sickle cell anemia (1); tuberculous adenitis (1); hepatic lobectomy for amebic abscess (1); mass in left flank (1); splenomegaly of undetermined origin (3); hepatomegaly of undetermined origin (2). Necropsies were performed in 9 cases and biopsies of the liver in 7 cases. In the other cases the final diagnosis was sufficiently clear to allow the above classification.

Reactions attributable to the injection of thorium dioxide sol occurred in 3 cases. In the case of Banti's disease the patient complained of pain in the lumbar region approximately five minutes after the injection. This was followed by a constricting type of pain in the lower portion of the chest bilaterally and in the lower sternal region. Spasmodic contractions of the recti abdominis muscles soon began and recurred about every two minutes for one and a half hours, accompanied by rapid, noisy breathing. After another hour and a half they gradually subsided, but recurred seven hours later and lasted for four hours. During these periods the patient was greatly distressed, but the pulse rate and temperature remained normal. This patient was not given further injections of the medium. We considered this reaction to be due to punctate hemorrhages in the spinal cord. The patient with the mass in the left flank complained of pain in the lumbar region for a short time soon after the first injection, but he did not suffer a reaction following the next two injections. The third patient, a child with tuberculous adenitis, had some puffiness of the eyes and face which was noticed the day following the first injection and persisted for about three days, during which time another injection was given.

None of the other patients had reactions of any kind, and to date none of them has shown any abnormal manifestations which can be ascribed to the presence of the medium in the organism even months after the injections.

Three patients died within a short time following one injection in 2 cases and two injections in the third. These patients were moribund at the time of the injection, and the injections were not considered to have precipitated death. None of these patients is included in the 40 cases reported in this paper.

In evaluating this method of diagnosis in the 40 cases in which the test was applied, the following is a fair appraisal. The examination was diagnostic of the nature of lesions in the liver in 13 cases, in 6 of which either biopsy or necropsy was performed; in the other 7 cases there was no reasonable doubt concerning the diagnosis. Seven of these were metastatic carcinoma of the liver, one a hepatoma, 4 instances of portal cirrhosis and one a case of hepar lobatum. The examination gave evidence suggestive of the nature of liver disease in 6 cases, in 4 of which biopsies confirmed the nature of the disease; in one other case necropsy was performed, and in the sixth case there was no reasonable doubt of the nature of the disease. In 4 of these 6 cases hepatitis or cirrhosis was present, in one there was a supposedly primary tumor of the liver, and in another hepar lobatum was found. The nature of an undiagnosed abdominal mass was determined in 4 cases; in 2 patients the evidence given by the examination was confirmed at operation. In 2 of these cases a mass or masses were found to be due to enlargement of both the liver and spleen, in another the mass was shown to be an enlarged spleen, while in a fourth the mass was proved not to be the spleen. The method was of no value or confirmatory only of enlargement of the liver or spleen in 13 cases; in one it confirmed the absence of the left lobe of the liver following lobec-

FIG. 1. Flat roentgenogram of abdomen before injection of thorotrast.

tomy, while in 2 other cases it merely showed that the liver and spleen were not enlarged. These 16 cases included a number of conditions, such as leucemia, Banti's disease, portal thrombophlebitis, passive congestion of the liver, enlargement of the liver and spleen of undetermined origin, and lobectomy for liver abscess. In one of these cases necropsy verified the findings.

In only one of the 40 cases did the method lead to an incorrect diagnosis. This was a case of enlarged liver with jaundice and ascites in a man sixty-five years of age. The roentgenographic diagnosis given was metastatic carcinoma of the liver. There were large vacuolated areas in the liver as shown by the roentgenogram, the cause of which was not explained at necropsy. The case proved to be one of biliary cirrhosis due to obstruction of the common duct, probably by a stone. It is possible that long-standing obstruction of the common bile duct may cause such distention of bile capillaries as to impair the function of the reticulo-endothelial cells. This appearance, however, was not noted in another case of obstructive jaundice.

FIG. 2. Same case as Figure 1 after injection of thorotrast, showing small cirrhotic liver, "*a*," and large spleen, "*b*."

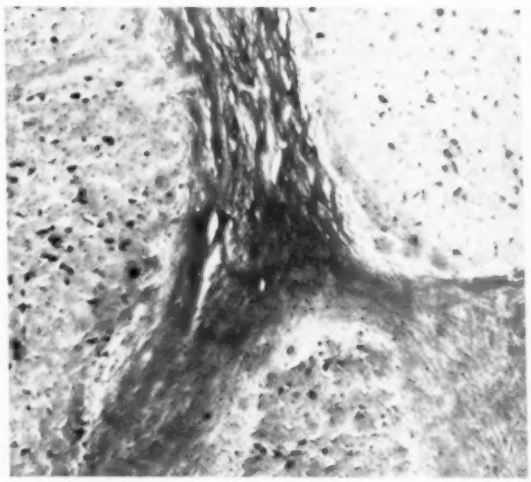

FIG. 3. Photomicrograph of liver of same case as Figures 1 and 2, showing islands of liver tissue with clumps of thorotrast and intervening fibrous bands without thorotrast. ×72.

TYPES OF LESIONS DIAGNOSED

Structural alterations of the liver are demonstrable when the proper technique is used and when several films with slightly varying exposures are made. The failure of others to visualize structural changes has undoubtedly been due to faulty technique.

Cirrhosis of the liver may be definitely diagnosed by this method when the liver is shown to be smaller than normal and to contain small islands of opacity closely set with intervening non-opaque areas. This is the appearance seen in the terminal stages of portal cirrhosis. The islands are the small areas of liver tissue remaining in the fibrotic organ. The spleen is usually shown

to be moderately enlarged and of normal or supernormal density. The films illustrated in Figures 1 and 2 are those taken before and after the injection of thorotrast in a man who died of Laennec's cirrhosis. The photomicrograph in Figure 3 indicates the reason for the roentgenographic appearance of the liver after the injection of the opaque substance. In those cases in which the amount of fibrous tissue is not as great or forms a finer meshwork the islands of liver tissue do not appear so distinct, and the density of the liver is greatly reduced because of reduction in the amount of functioning reticulo-endothelial cells. This type is illustrated by Figure 4, and a roentgenogram of the liver and spleen of the same patient after necropsy is shown in Figure 5.

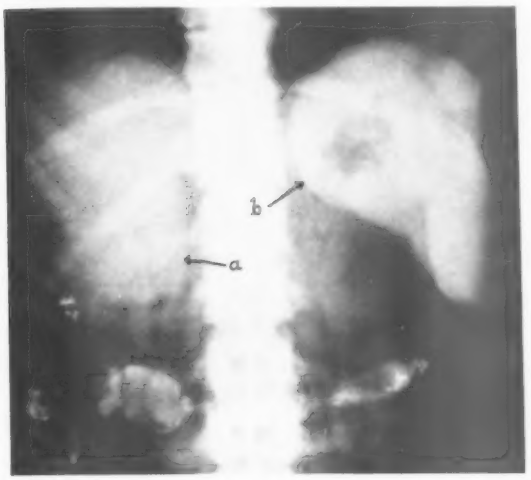

FIG. 4. Cirrhotic liver, "*a*," of much less density than enlarged spleen, "*b*."

The diminished density of the liver shadow in these cases is due partly to partial replacement of liver parenchyma by fibrous tissue, but probably more largely to the poor development of reticulo-endothelial cells in masses of regenerated liver tissue. Cirrhosis of the liver may be diagnosed in the subclinical stage before ascites occurs or a positive bromsulphthalein test is obtained on the evidence afforded in this manner of reduction of functioning reticulo-endothelial elements. Such a case is illustrated in Figure 6, in which the liver is seen to be small and shows diffuse mottling, while the spleen is greatly enlarged. This patient was a woman thirty-six years of age who had had a prolonged febrile illness with intense jaundice at the age of twenty, but who now had no symptoms suggestive of hepatic insufficiency.

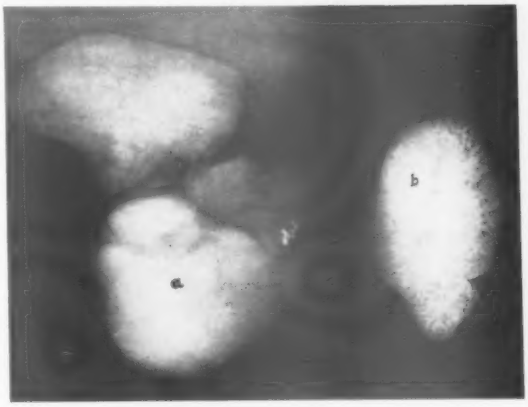

FIG. 5. Roentgenogram of liver, "*a*," and spleen, "*b*," of same case as Figure 4 after necropsy.

Subacute hepatitis may be suspected by this method in conjunction with the clinical picture when the liver is enlarged and there is reduced density of its shadow with small vacuoles irregularly placed, or even if the liver is not larger than normal, by diffuse mottling of the shadow. Enlargement of the spleen is additional evidence of this condition. Focal areas of necrosis are sug-

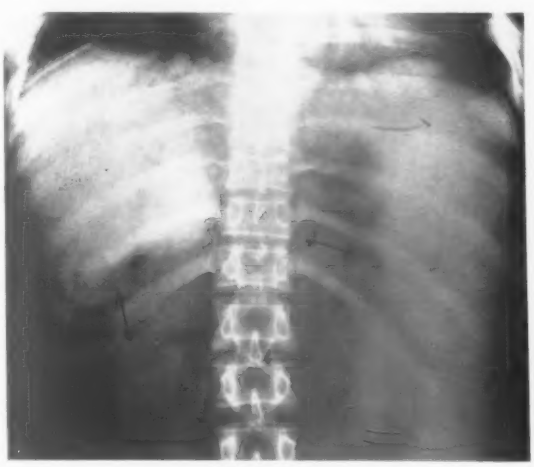

FIG. 6. Subclinical cirrhosis of the liver. Small mottled liver, "*a*," and greatly enlarged spleen, "*b*."

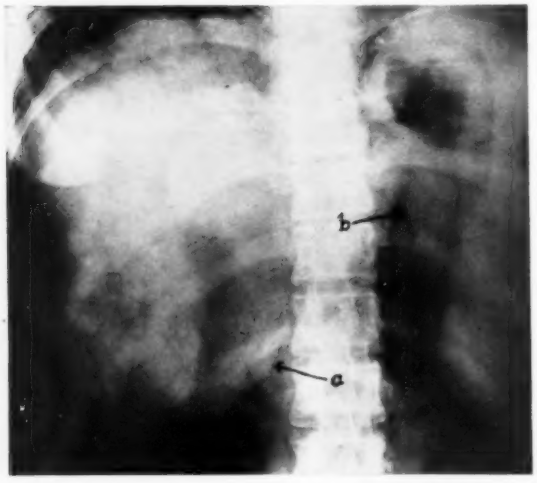

FIG. 7. Syphilis of the liver (hepar lobatum), "*a*," with enlarged spleen, "*b*."

gested by a slight tendency toward diffuse mottling in a liver of normal size in association with subacute febrile jaundice.

Diffuse syphilitic cirrhosis would probably give the same appearance by this method as non-syphilitic portal cirrhosis. Hepar lobatum is easily diagnosed. The liver is enlarged and shows peculiar large lobulations with irregularity of the edge. The spleen may be considerably enlarged. The film illustrated in Figure 7 shows this condition in a woman thirty-six years of age who had syphilis. A similar case was proved at necropsy.

Metastatic carcinoma of the liver is easily demonstrated, and the finding of metastases in this organ may save the patient from an unnecessary operation. Metastatic nodules appear as circular, relatively non-opaque areas, often surrounded by a narrow rim of density more opaque than the normal intervening parenchyma. This appearance is due to the fact that metastatic nodules have a poorly developed reticulo-endothelial structure and that compression of the surrounding hepatic parenchyma causes local concentration of reticulo-endothelial units. The appearance of metastases is shown in Figure 8, while Figure 9 shows the appearance of the liver after it was removed from the body. The photomicrograph in Figure 10 illustrates the appearance of the thorium dioxide in the reticulo-endothelial cells in the metastatic nodule and in the surrounding liver tissue.

FIG. 8. Metastatic carcinoma of the liver. Arrows point to lesions.

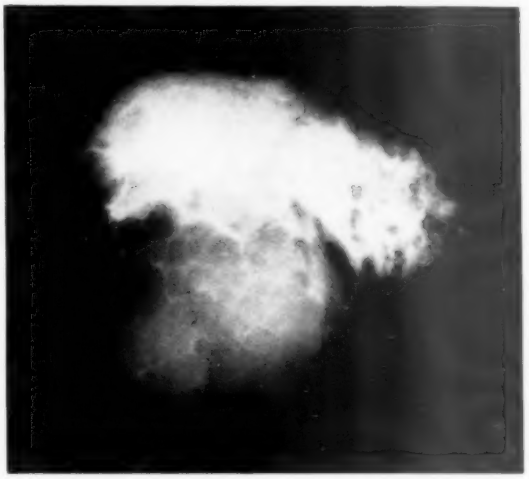

FIG. 9. Roentgenogram of liver of same case as Figure 8 after necropsy.

A primary tumor of the liver is to be suspected if this halo of greater density surrounding a less opaque area is not present. Two such cases occurred in this series. One was diagnosed before operation.

In passive congestion of the liver the

only alterations are enlargement and some decrease in density.

The question sometimes arises as to whether a mass in the upper part of the abdomen is the liver or spleen. This method allows positive determination of this point. There were 4 cases in this series in which the method was used for this purpose. In one it was shown that the mass was not the spleen as had been suggested by several clinicians. The use of the examination for such a purpose may therefore be of great value.

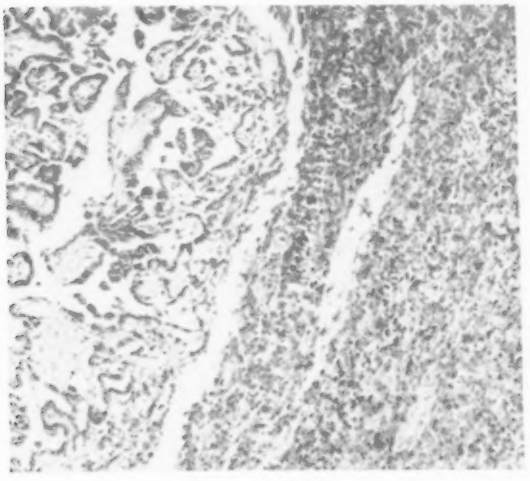

Fig. 10. Photomicrograph of liver of same case as Figure 9, showing clumps of thorotrast in liver and relative absence of them in the cancerous area. ×72.

In one case in this series a Riedel's lobe which had not been evident clinically was visualized (Fig. 11).

The least aid was obtained from this method in the differential diagnosis of diseases implicating the spleen. It was impossible to positively differentiate structurally the spleens in leucemia, Banti's disease and purpura hemorrhagica, although as one might expect, the large fibrotic spleen of Banti's disease and the infiltrated spleen of leucemia appeared less dense than the normal spleen. In one case of xanthomatosis and in one of sickle cell anemia in the stage preceding atrophy of the spleen the appearance was no different from that of

Fig. 11. Riedel's lobe shown at "*a*," moderately enlarged spleen at "*b*," and well-visualized kidneys at "*c*," "*c*."

spleens involved in other diseases. We had expected to find a reduction in the ability of the spleen to ingest the opaque substance in the case of xanthomatosis on the assumption that the reticulo-endothelial cells might already be completely filled with lipoid material. Further experience may show this to be so. A similar appearance might be expected in Gaucher's disease.

Accessory spleens are well visualized in the films. These appear as small, round

Fig. 12. Fluid in abdomen indicated by separation of liver edge from costal border.

shadows adjacent to the main spleen. They were demonstrated in 3 cases in this series.

The presence of free fluid in the abdomen can readily be determined by the presence of a space between the edge of the liver and the lateral costal margin. This point is illustrated in Figure 12.

This series did not include cases of liver abscess, hemangioma of the liver or echinococcus or other cysts of the liver, but this method of diagnosis would be of definite value in a determination of the nature or at least the presence and site of these lesions. The presence of tumors, abscesses or infarcts of the spleen might also be ascertainable by this method. Rupture of the liver or spleen might conceivably be diagnosed also.

INDICATIONS FOR THE METHOD

Although this method, as far as we can see, involves no risk to the patient either immediately or remotely, it should not be used promiscuously. We consider the following conditions to be reasonable indications for its use: (1) any enlargement or alteration of the liver the cause of which is not known; (2) the presence of a mass in the abdomen which might be the liver or spleen but the nature of which is uncertain; (3) the question of an abscess in the liver as the cause of sepsis when no other focus can be located; (4) suspicion of the presence of metastases in the liver in cases of carcinoma of an abdominal viscus when the question of operation for any reason arises; (5) the desire to follow the progress of intrahepatic disease; (6) the presence of splenomegaly, the cause of which cannot be determined by other methods, and (7) the question of the presence of free fluid in the abdomen.

CONTRAINDICATIONS TO THE METHOD

Although several authors have mentioned that severe intrahepatic disease such as hepatitis and cirrhosis contraindicates the use of this method we have not been able to verify this statement. A number of cases of this kind have had the examination without untoward results of any kind. Moribund patients should naturally not be subjected to it. Simultaneous severe liver disease and renal insufficiency has been adduced by Kadrnka[2] as a contraindication since most of the thorium dioxide is eliminated through the bile and urine, and its continuous presence in the circulating blood might be detrimental.

SUMMARY AND CONCLUSIONS

A method of visualization of the liver and spleen developed mainly by Radt, Oka and Kadrnka has been described. This consists in the intravenous injection of thorium dioxide sol from which the radiopaque thorium dioxide is engulfed by the reticuloendothelial cells of the body. These cells being most numerous in the liver and spleen allows these organs to be better visualized than other parts of the body. This examination is a laboratory procedure and should in no way replace clinical methods of diagnosis. It is apparently harmless and contraindications are negligible. Reactions are few and are not serious. Forty cases have been studied by us and the value of the examination in this series has been discussed. The method was diagnostic of the nature of lesions of the liver in thirteen cases. It gave evidence suggestive of the nature of liver disease in six cases. The nature of an undiagnosed abdominal mass was determined in four cases. No value was derived from the method or confirmatory evidence only was obtained of enlargement of the liver or spleen in sixteen cases. In one case the appearance of the liver led to a wrong diagnosis.

The following points may be determined by means of this method: (1) the presence of enlargement of the liver or spleen; (2) decision as to whether a mass in the upper abdomen is liver, spleen or something else; (3) the presence of metastases in the liver; (4) the presence of a primary tumor, cyst or abscess in the liver; (5) in many cases the nature and extent of such intrahepatic diseases as cirrhosis, subacute hepatitis or extensive scarring of the

liver from syphilis; (6) the progress of such diseases of the liver; (7) the presence of free fluid in the abdomen; (8) the existence of such lesions of the spleen as tumor, infarct, abscess, fibrosis and possibly leucemia and xanthomatosis or Gaucher's disease, and (9) the existence of rupture of the liver or spleen.

As an adjunct to previously used methods of diagnosis the method is therefore of considerable value. Greater experience will reveal the true value, the fine points and the limitations of the method.

NOTE: The illustrations in this paper do not do justice to the details as given by the roentgenograms themselves. The authors will be only too glad to demonstrate the original films to any who may happen to visit Washington, D. C.

Gratitude is due Major Paul E. McNabb, Curator, Army Medical Museum, for the photomicrographs and helpful suggestions.

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SOME EVIDENCES OF INTRACRANIAL DISEASE AS REVEALED BY THE ROENTGEN RAY*

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NEW YORK CITY

TO OBTAIN an idea of the scope of the roentgen ray in the diagnosis of intracranial disease, it must be borne in mind that the film presents no more nor less than a collection of shadows to which, unfortunately, the name of "picture" has been given, and that the value of the interpretation of these shadows is in direct proportion to the experience of the interpreter.

During the past few years a large number of cases have been checked surgically or by post-mortem examination which has permitted the collection of many proved cases from which it is possible, at least theoretically, to build a rather solid foundation on which to base the diagnosis of current cases. This may sound almost as if diagnosis has now been reduced to a cut and dried formula, but this is far from true. I believe it is safe to say that there are no two cases exactly alike; and I also firmly believe that no conclusion should be drawn until after one has become acquainted with the clinical findings, for in that way only can the various shadows be properly evaluated.

Before going further, let me emphatically state that it is useless to attempt to draw conclusions from technically poor films. They must be of excellent quality, and stereoscopic.

Just as I have said that no two cases are exactly alike, so also am I convinced that no two skulls are exactly alike. Hence, we are at once confronted with the problem—what is a normal skull? As it is easier to describe an abnormality than it is to describe a normality, I think we must be content to consider a skull as normal if no abnormality can be demonstrated.

Figures 1 to 6, inclusive, show changes that are not considered of pathological significance. Figure 1 demonstrates quite clearly the so-called interclinoid bridging. This varies from fine strands of calcification in the edges of the diaphragm of the

FIG. 1. Interclinoid bridging.

FIG. 2. Petroclinoid bridging.

* From the Department of Roentgenology, New York Neurological Institute. Read before New York Clinical Research Society, January, 1932.

Fig. 3. Calcification in falx in frontal region.

Fig. 5. Calcification in choroid plexus.

sella to massive bony bridges as seen in the illustration. These changes may well be of significance from an endocrinological point of view, but for the purpose of this article they must be considered as without pathological significance. Interclinoid bridging is seen in about 14 per cent of skulls. Figure 2 shows a type of calcification which involves the free edges of the tentorium as it sweeps backward from the dorsum. This is sometimes called petroclinoid bridging. Again, in Figures 3 and 4 we have plaques of calcification in the falx which are, as far as can be determined, without much pathological significance. We find calcification in the falx in about 9 per cent of skulls. In Figure 5 calcification is seen in the choroid plexus. This is most frequently found in the glomus of the choroid and is seen in about 13 per cent of all cases. It apparently has little or no significance. Figure 6 shows the diploic veins, or so-called veins of Brechet, to be

Fig. 4. Extensive calcification in falx and tentorium.

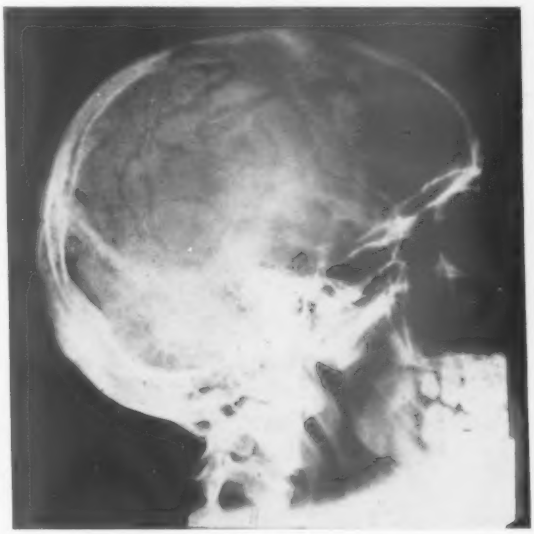

Fig. 6. Large diploic veins.

FIG. 7. Spongioblastoma.

exceptionally well defined and rather large. This is not an uncommon finding, and unless these large channels are seen unilaterally they are of little more than passing interest. These illustrations demonstrate a few of the more common conditions seen which might tempt one to consider a skull as pathological.

I am in the habit of roughly classifying calcifications into three groups: punctate, linear and amorphous. It is frequently impossible definitely to classify a given deposit of calcium, and often all three types will appear in one lesion, but when calcification can be classified it forms another cog in the diagnostic wheel which I think is often of considerable importance.

When the pineal gland is calcified, as it is in a little over 50 per cent of all skulls, it is, of course, visible. It was Naffziger who first pointed out the diagnostic significance of a change in position of this gland, but it remained for Vastine and Kinney to work out a chart on which the pineal position could be plotted and more accurately compared to its normal location. This scheme was later tested rather thoroughly in a large number of cases by Dyke and found to be a very reliable factor in diagnosis. For a description of this method, I would suggest reading the articles by the authors mentioned, but, briefly, it consists of plotting the position of the gland on two graphs. The anteroposterior position is determined by measuring the distance of the gland from the inner table of the frontal bone, and its distance from the inner table of the occipital bone, and then plotting the first measurement against the sum of the two. The superior-inferior position is plotted in a similar manner by taking the measurements from the vertex and from the inferior portion of the posterior fossa. These are then compared with the normal position which has been determined to within fairly narrow limits. Of course, a lateral shift is easy to see in true posteroanterior views. In the presence of a definite pineal shift, one is justified in feeling fairly certain that it is caused by a pathological process, and the direction of the shift gives a clue to the location of the lesion.

With this as a background, we will now take up several of the pathological processes and consider their manifestations on the film. First to be discussed are the gliomas. I shall not attempt here to present a classification of these tumors, as, to the best of my knowledge, there is still considerable lack of agreement on this point between surgeons and pathologists. Roughly, however, about 50 per cent of in-

FIG. 8. Astrocytoma.

tracranial growths will fall into this group, and of these, about 13 per cent calcify sufficiently to be demonstrable in the roentgenogram. But in spite of this small percentage showing calcification, we are able to make a highly probable diagnosis in about 50 to 60 per cent of all cases having such lesions.

The skull seen in Figure 7 is that of a case which proved to be a spongioblastoma, also called glioblastoma multiforme. This is the type of tumor most frequently encountered in the glioma group. They usually occur in the cerebral hemispheres, but in spite of their comparatively rapid growth they often become cystic and frequently calcify. It is not infrequent to find them attaining tremendous size without signs of pressure, with a history comparatively short and progressive. When calcification occurs, it may take any or all of the three forms mentioned, but it is my feeling that a careful study of the deposit will usually show it to be of the amorphous type, with not infrequently string-like projections as might be expected in an infiltrating type of tumor. This is fairly well shown in the calcification seen in the temporoparietal region.

The astrocytoma, an example of which is seen in Figure 8, is almost as common a

Fig. 9. Oligodendroglioma.

Fig. 10. Posterior fossa lesion—note pressure signs.

type of glioma as the spongioblastoma, but it is much more slowly growing, is often cystic and, as might be expected, not infrequently calcifies. This type of tumor occurs anywhere in the brain. The calcium seen in an astrocytoma does not differ essentially from that of other gliomas, but I believe that at least part of the deposit will usually show punctate characteristics. Of course, without calcification the localization of this type of tumor presents the same problem as does the spongioblastoma, but if by indirect means we are able to locate a lesion, then usually the duration of the history will prove to be an important differential point.

The oligodendroglioma is perhaps the slowest growing of all the gliomas, and is also comparatively rare. Figure 9 is of such a tumor. It is a solid tumor as a rule, but may be soft, and is characteristically found in the cerebral hemispheres. The slow growth is evidently one of the factors permitting calcification, for these tumors often show calcium deposits which are usually amorphous and often combine with the string-like type. This would be expected as the calcium is evidently deposited along the blood vessel channels in the tumor. Patients with these tumors usually give long histories often extending over years, which

FIG. 11. Same as Figure 10 six months after decompression.

is a fact to be considered in making a diagnosis, and will usually differentiate these tumors from the spongioblastomas which frequently show similar calcifications.

The medulloblastomata usually occur in the posterior fossa in children, are frequently attached to the roof of the fourth ventricle, and so, due to their rapid growth, give rise to prompt increase of intracranial pressure. They rarely calcify, although when they do the type of calcification is not characteristic. The signs of increased pressure, the age of the patient and the history usually suffice for a diagnosis. It might be well to mention in passing that it is the medulloblastoma which, of all the gliomas, is the most sensitive to radiotherapy.

The ependymomas I shall merely mention in passing, as they are comparatively rare. They present no characteristic roentgen findings, but if they calcify, the position as determined stereoscopically may suggest the type of tumor. The ependymomas are, of course, of ependymal origin, and will usually be found in the midline and attached to the fourth ventricle or the aqueduct. When one sees calcification in the posterior fossa of a child, it is, in the vast majority of cases, an ependymoma or possibly a medulloblastoma.

Pressure changes occur with considerable rapidity, particularly in a child's skull. A few weeks of pressure will produce a marked change and, conversely, after the pressure is relieved, the signs will disappear with equal or greater rapidity. Figure 10 is a roentgenogram of a child's skull with a posterior fossa lesion. The signs of increased intracranial pressure are clearly evident, with the typical deepening of the convolutional impressions and separation of the sutures. Figure 11 is of the same skull six months after a suboccipital decompression. It will readily be seen that the signs of pressure have been considerably diminished.

Now let us consider for a few moments the roentgen evidence of pituitary tumors. We will, for this discussion, leave out the malignant growths such as adenocarcinoma, and confine ourselves to the adenomas. First of all, let me warn against making a diagnosis of pituitary tumor every time a large, atrophic sella is seen, for as so often happens, the larger the sella, the larger the pitfall it may prove to be.

Pituitary adenomas constitute varying proportions of intracranial tumors in different clinics—some report as high as 19 per cent, others about 5 per cent. These tumors may be roughly classified as intra- or suprasellar. It is rare to find evidence of

FIG. 12. Pituitary adenoma.

general increased pressure with pituitary adenomas, but as one might expect, local evidence of pressure is the usual finding. The intrasellar type produces a ballooning of the sella with depression of the floor, depending on the extent of undermining of the sphenoid cells, thinning of the dorsum and atrophy of the tuberculum. The suprasellar type usually produces a flattening of the sella with more actual dorsal destruction. It is often possible, by a study of the sella, to determine whether the destruction is chiefly in the anterior or posterior portion, and this, with the not infrequent skull changes accompanying pituitary tumors,

Fig. 13. Pituitary adenoma.

will allow of a definite diagnosis of a chromophobe or chromophil adenoma. The chromophobe with the hypopituitary symptoms is the more common. Of course, there comes a time in the development of pituitary tumors when the sella destruction is so great that a differentiation by the roentgen ray between supra- and intrasellar types becomes impossible. Figures 12 and 13 show the intrasellar type of pituitary adenoma. It will be seen that the floor has been depressed and that there is a ballooning of the sella with atrophy of the dorsum, but there is no evidence of increased intracranial pressure. In Figure 14 almost the

Fig. 14. Pituitary adenoma.

entire sella has been destroyed. The dorsum has been flattened downward and backward and there is much undermining of the tuberculum. This tumor has progressed to such an extent that it would be impossible to state whether it began as an intra- or suprasellar lesion. Figure 15 is shown not so much for the sellar changes which are very slight, as for the diffuse, somewhat irregular hyperostoses seen over the vault, a not infrequent accompaniment of pituitary lesions.

Fig. 15. Pituitary adenoma.

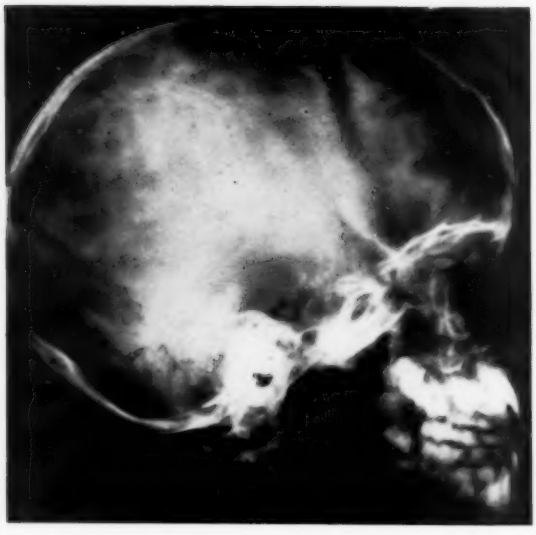

FIG. 16. Suprasellar cyst.

Craniopharyngeal duct tumors, so-called Rathke's pouch cysts, or better, pharyngiomas, are epithelial growths arising from the anterior portion of the pituitary and lie above the sella. They usually occur in children, frequently are large enough to obstruct the foramina of Monro, and produce signs of increased intracranial pressure. Calcification in their walls is not uncommon, hence the roentgen ray will often reveal their presence and make a definite

FIG. 17. Suprasellar cyst.

diagnosis possible; and not infrequently, by a careful study of the anterior portion of the sella and a consideration of the age of the patient, especially if signs of pressure are evident, an equally positive diagnosis may be made even though the tumor be uncalcified. Of course, not every suprasellar calcification means a pharyngioma. A glioma, such as the kind occasionally seen arising from the optic chiasm, may calcify and produce a similar picture. A meningioma arising from the pituitary pedicle also may calcify, or even a chordoma of the pedicle has been reported as having calcified. It might be noted, however, that a

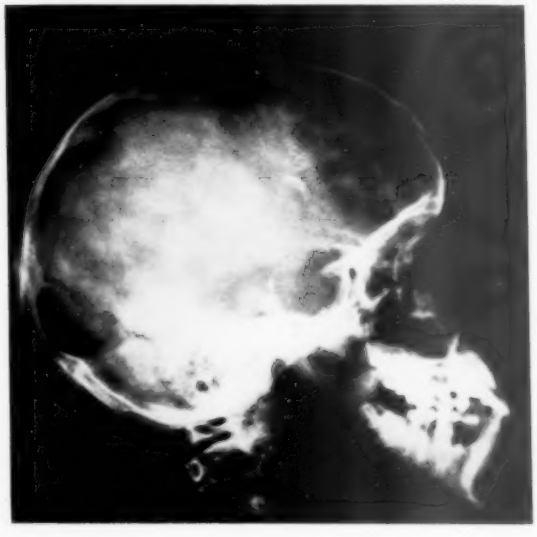

FIG. 18. Suprasellar cyst.

suprasellar meningioma will very often show some signs of bone hypertrophy together with signs of atrophy. This is not a constant finding but often permits of a differential diagnosis.

We have just been considering destruction of the sella due to its traditional enemy, the pituitary tumor. Now, let us look at sellar atrophy, also without signs of general increased pressure, but not due to pituitary disease. It has been my conviction for some time that temporal lobe tumors frequently produce such atrophy, but usually a careful study will show it to be asymmetrical, the clinoids and dorsum on one

side being more atrophic than those on the opposite side, but usually the floor will be intact, an important differential point. Also, with these tumors the convolutional impressions on the temporal bone will frequently be slightly accentuated on the affected side. This, however, is at times difficult to determine, as the temporal bone often shows impressions without apparent significance. It is advisable to obtain films in the Granger position when such lesions are suspected, as this position often permits of a comparison between the two sides of the sella.

Another type of tumor often producing a similar picture is the acoustic neuroma, the so-called cerebello-pontine angle tumor. Here, however, we usually see the atrophy chiefly confined to the dorsum which may be pressed forward and also the petrous ridge may be atrophic on the involved side. This is almost diagnostic when seen, particularly with any clinical findings pointing to such a lesion. Also, metastatic disease and osteochondromas with occasional meningiomas may produce changes in the petrous ridges which must be ruled out when making a diagnosis. Figures 19 and 20 are of a case of acoustic neuroma. One of the posterior clinoids can be seen as being pressed forward and considerably atrophied. Stereoscopically, this is much more evident than in the reproduction, and it can be noted that the petrous pyramid on the left side is decidedly irregular and eroded on its inner aspect.

Fig. 19. Acoustic neuroma.

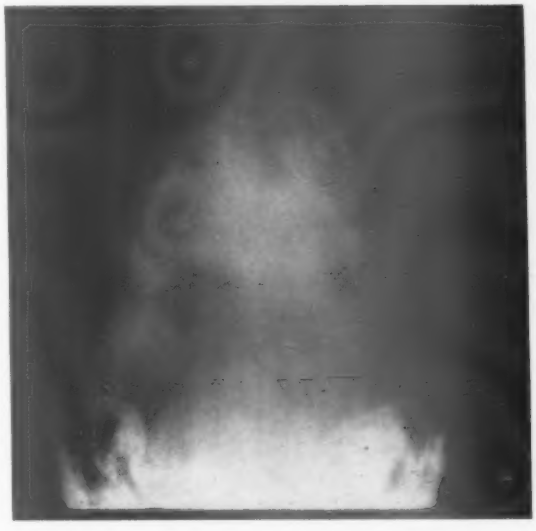

Fig. 20. Same as Figure 19.

We will now take up briefly a very important group of tumors which, although representing only about 13 per cent of the intracranial growths, offer as a rule better surgical prognosis than all the others. These are the meningeal fibroblastomata, usually known as meningiomas, first called endotheliomas. These occur usually as hard, well encapsulated, or soft, rather poorly encapsulated growths. They frequently attain considerable size before bringing the patient to a physician, because, the tumor being outside the brain, the effect is chiefly one of pressure displacement, and as the brain is able to accommodate itself to a considerable amount of such abuse, no early symptoms arise. These meningiomas often calcify but not characteristically, although calcification in their sites of election is strongly diagnostic evidence. On the other hand, these tumors often produce very characteristic bone changes. Whether bone proliferation or destruction occurs will depend upon whether osteoplastic or osteolytic tendencies predominate. When the effect is chiefly a destructive one, our

Fig. 21. Frontal meningioma.

diagnosis must of necessity be mostly by inference, unless the edges of the defect show some of the changes seen in the illustrations. When the effect is a productive one, we are treading on fairly solid ground. The overlying bone usually shows considerably increased vascularity and frequently small spiculations can be seen projecting into the tumor area. A peculiar ray-like bony formation is occasionally seen and is pathognomonic; again, there is massive and extensive bony overgrowth. These meningiomas sometimes occur in the olfactory groove, and not infrequently will penetrate the roof of the orbit, often with enlargement of the sphenoid fissure, to produce unilateral exophthalmos. The illustrations will show some of the changes we have come to recognize as being due to the meningiomas.

Figure 21 shows a meningioma in the frontal region which has produced a rather typical ray-like area of bone production and destruction. In Figure 22 we have in the superior parietal region an increased amount of vascularity, together with some slight evidence of bone production. This is

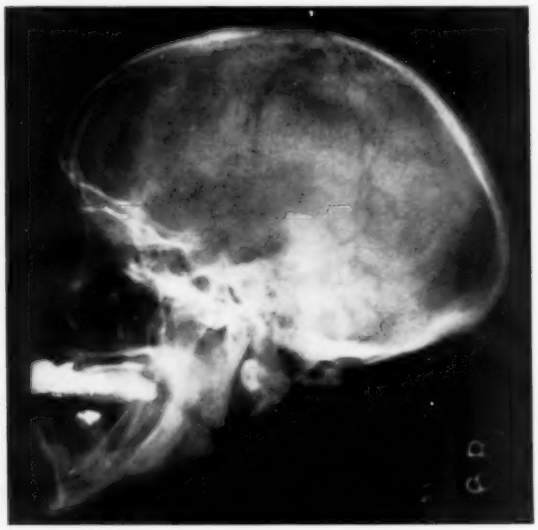

Fig. 22. Parasagittal meningioma.

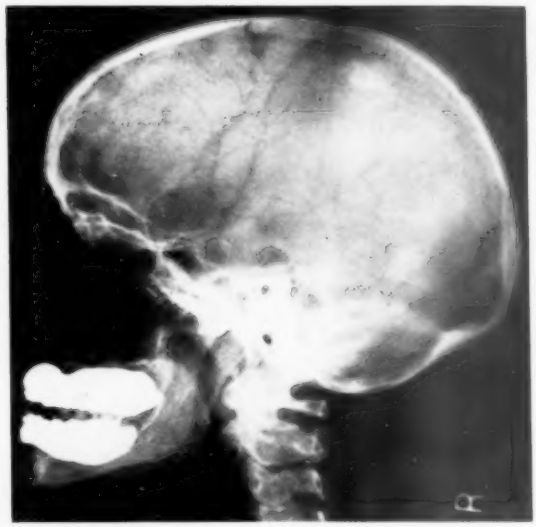

Fig. 23. Calcified meningioma.

quite characteristic of the parasagittal meningiomas. Another of this same type is seen in Figure 23 but here we have calcification which aids considerably in the localization. Again, in Figure 24 we have in the inferior posterior frontal region a meningioma which has as its chief characteristic, bone destruction. Most of these cases, as can be seen, show evidences of bone atrophy in and about the sella. Figure 25 shows one of these tumors in which the bone production characteristic predominates, and Figure 26 is a soft-tissue film showing spiculations as seen with these tumors, this particular one having penetrated the skull.

The blood vessel tumors and anomalies are not common. They constitute but 1.9 per cent of the tumors in Cushing's series. We have found several over a period of years and I believe it worth while to show a few of the changes we have come to associate with these lesions. They are usually divided into two main classes: the angiomatous malformations and the hemangioblastomata. There is no way to differentiate definitely between these two by the roentgen ray alone, but one would be greatly surprised to find a hemangioblastoma anywhere but in the cerebellum. It is, however, frequently possible by a study of

Fig. 24. Temporo-fronto-parietal meningioma.

the vessel channels leading to the suspected area to tell whether the lesion is chiefly venous or arterial, if one bears in mind the usual finding that the arterial channels tend to taper, whereas the venous channels tend to remain of constant caliber, and roughly, that the arterial channels tend to course from below upward and backward, whereas the venous channels are usually seen extending upward and forward. Of course, in the deep-seated lesions we are deprived of this evidence. When the lesions are superficial, the overlying bone may show changes which are easily confused with those produced by the meningiomata.

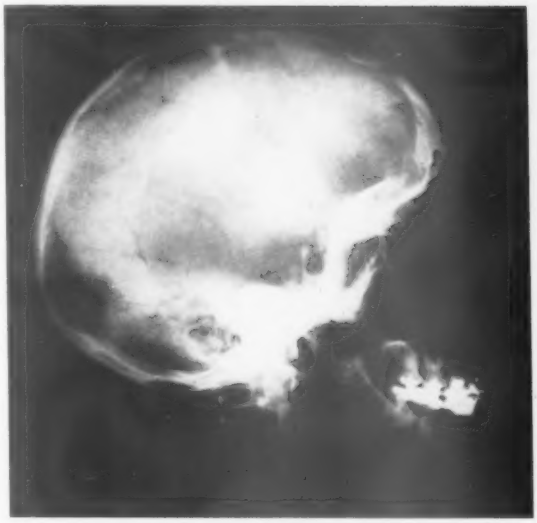

Fig. 25. Sphenoid ridge meningioma.

Bone spiculation is common to both, but bone production to any extent would be greatly in favor of the meningiomas and against the angiomas. The large, tortuous blood vessel channels usually seen with the angiomas are of considerable differential significance and, of course, when a bruit can be heard with a stethoscope the diagnosis is made. The deep-seated lesions often calcify along the vessel walls and, when this can be recognized, a highly probable diagnosis can be made. But when the tumor

Fig. 26. Meningioma penetrating both tables of skull.

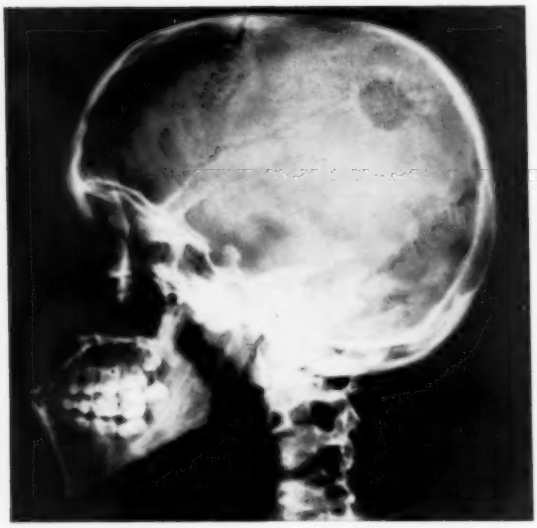

Fig. 27. Hemangioma.

Fig. 29. Carotid aneurysm.

becomes cystic, as is sometimes seen in the hemangioblastomas, it is practically indistinguishable from the gliomas which have become cystic. The perithelioma is, perhaps, in a discussion of this type, of purely academic interest. Its exact relation to blood vessel tumors is indefinite, and it is probably indistinguishable from the angiomas. According to Ewing, it occupies a position somewhere between the angiomas and the endotheliomas.

In Figure 27 we have a rather typical bone change produced by one of these angiomas. The bone is seen to be extremely vascular, but the vascularity is localized in a sharply circumscribed area. Stereoscopically, it could be seen that there is considerable bony spiculation in this area. In Figure 28 we see in the occipital region one of these blood vessel malformations. Large vessel channels are seen leading to this region, and there is also considerable calcifi-

Fig. 28. Calcified occipital hemangioma.

Fig. 30. Carotid aneurysm.

cation, which is not uncommon, the calcium usually being deposited along the tortuous vessel channels.

In the immediate vicinity of the sella, we often see small spicules of calcification which are in the walls of the carotid artery where it joins the circle of Willis. This produces no change in the sella and is merely an evidence of sclerosis. It is seen in about 6 per cent of all skulls examined in our clinic. When we see calcification in crescentic lines beside the sella, particularly when we also see unilateral sella atrophy, and with any clinical symptoms referable to this region, it is quite safe to say that we are dealing with an aneurysm. In Figures 29 and 30 we have calcification in crescentic lines over the sella with considerable sellar destruction. Changes of this kind are quite characteristic of a carotid aneurysm.

This brief résumé of roentgenographic manifestations of intracranial pathological changes is by no means complete, but I hope it will be of some aid in allowing the formation of a "mental picture" of some of the more common lesions which occur in the skull.

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ROENTGENOLOGIC SKULL CHANGES IN THE ANEMIAS OF CHILDHOOD

REPORT OF A CASE: A FEW NOTES ON SIMILAR FINDINGS AMONG THE SKULLS OF PERUVIAN INDIANS*

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THE more recent literature on roentgenologic bone findings accompanying the various anemias emphasizes the occurrence of skull changes in association with these conditions. In the earliest reports which correlated blood diseases with the hematopoietic functions of osseous tissue, the skull was recognized as a participant in the generalized skeletal involvement. In 1870, Neumann of Königsberg was the first to point this out. More recently, however, specific skull changes have been ascribed to particular blood diseases. It would seem valuable to review some of the literature emphasizing such findings and to add a case showing a very striking modification of the cranial roentgenogram.

ERYTHROBLASTIC ANEMIA

In 1927 Cooley, Witwer and Lee reported 7 cases of anemia in children accompanied by splenomegaly and unusual bone changes. Five cases of this series were originally reported in 1925. Baty, Blackfan and Diamond, in a recent clinical and pathologic study of erythroblastic anemia, added 20 cases to the 26 which already existed in the literature.

The condition usually affects children descended from nationalities bordering along the Mediterranean, especially Italians and Greeks. The cause seems to be congenital, but not hereditary. In most cases the disease is well advanced before the end of the first year. The patients present a very striking appearance. The skin shows a peculiar muddy or icteric tinge, but the sclerae are clear. Many of the patients have been described as mongoloid in appearance. The head is usually greatly enlarged, particularly in the parietal regions. Both the spleen and the liver are increased in size. The blood picture is characteristic. The large number of erythroblasts found in the circulating blood, especially following splenectomy, led Cooley to apply the term "erythroblastic anemia of childhood" to this disease. Bone marrow stimulation is also evidenced by leucocytosis and immature forms. The *absence* of evidence of increased fragility is considered important.

The icteric tinge mentioned above is ascribed to chronic hemolysis. The cases in the literature which have been studied for hemolysis seem to show that it is a constant feature.

The changes in the skull and long bones as shown by the roentgen ray are very characteristic. The majority of the authors who have reported on cases of erythroblastic anemia have indicated the occurrence of significant bone changes, particularly in the skull. The most detailed consideration of these features has been given by Mandeville and by Baty, Blackfan and Diamond. In brief, these findings can be summarized as follows:

In the early stages or in mild cases the cranial vault shows an increased porosity of the medullary portion of all the bones. At this stage these bones have a mottled appearance. Both the outer and inner tables of the skull are thin. In the later stages there is considerable thickening of the diploë which may even be four times its normal width. The outer table is very thin—frequently to such a degree that it cannot be distinguished in the roentgenogram. There are striations which run perpendicular to the skull tables. These striations are so fine and so numerous that they have been described by Baty and his coworkers as hair standing on end.

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The long bones are wide because of an increase in the medullary portion. Rarefaction of the medulla results in a transparent appearance on the roentgenogram. There is trabeculation of the medulla which is more marked at the metaphyseal end. There is considerable thinning of the cortex which may lead to pathologic fracture. Periosteal elevation has never been observed.

Joint changes have not been recorded.

Irregular trabeculations in the pelvis, vertebrae, ribs, clavicles, and scapulae have been observed.

Since Cooley's original report many cases other than those of erythroblastic anemia, such as sickle cell anemia and congenital hemolytic icterus, have been mentioned in the literature, showing a skull roentgenogram quite similar to that identified with erythroblastic anemia. In each instance, however, it is important to note that the anemia belongs to the hemolytic group.

Next to erythroblastic anemia, the characteristic skull changes have been observed most frequently in the sickle cell type of anemia. In this latter condition, the literature is not definite regarding changes in other parts of the skeleton. Whereas most authors emphasize the fact that the alterations of the skeleton in general, particularly the long bones, are a constant finding in erythroblastic anemia, such reports are lacking for sickle cell anemia. Grulee mentions one case of sickle cell anemia in a child which showed skull pathology but no long bone changes. Such information would undoubtedly be of great aid from a roentgenologic differential diagnostic point of view.

The following case is presented primarily to illustrate the skull changes which have been indicated above.

CASE REPORT

Case 1. S. S., a colored male child, aged fifteen months, was brought to the Northwestern University Pediatric Clinic because of a deformity of the head. A swelling of the middle of the forehead was noticed by the grandparents eight months prior to admission, and a central depression of the head was noticed six months before examination.

The child was delivered by caesarean section at full term, weighing 4 lb. 15 oz. The mother died six weeks following the child's birth, so that exact knowledge regarding the early weeks of life could not be elicited except that the early days of life were spent in an incubator and that the child presented numerous feeding problems. The first tooth appeared at nine months; the child could sit alone at six months, and stand by holding on to an object at thirteen months. At the time of admission the infant was on a well-balanced diet of cereal, vegetables and one quart of milk daily. He had received both cod-liver oil (one tablespoonful daily) and orange juice regularly since birth.

Except for an occasional cough or mild cold during the winter months, and a mild diarrhea at thirteen months, the child had apparently been in good health.

Family History. Little was known concerning the father. As has been indicated, the mother died six weeks following caesarean section, the exact nature of her illness being unknown except that the grandparents of the child stated she had "heart trouble" and "lung trouble" and that the caesarean wound did not heal.

A sister of the patient aged three years is living and well. A second pregnancy terminated in a still-birth. The patient was the fruit of the third pregnancy.

Physical Examination. Physical examination presented a well-developed and well-nourished colored infant, mentally alert, whose head was quite large and so peculiarly shaped that it immediately attracted attention. The parietal regions bulged prominently and there was a central depression corresponding to the site of the sagittal suture. There were similar furrows marking the position of the lambdoid and coronal sutures. There was a depression at the site of the anterior fontanelle admitting one finger. It seemed as though the inner table was closed and the outer table was lacking. The posterior fontanelle was closed. The forehead was broad and the frontal bossae fairly prominent. In the mid-region of the forehead was a rounded tumescence about the size of a dollar (5.5×5.5 cm.), solid in consistency, fixed but not adherent to the skin. It was not tender even under firm pressure.

The measurements of the skull and body were:

Suboccipito-frontal	circumference	49 cm.
Suboccipito-frontal	diameter	15 cm.
Occipito-frontal	circumference	52 cm.
Occipito-frontal	diameter	17 cm.
Biparietal	diameter	15 cm.
Bifrontal	diameter	10 cm.
Bi-acromial	diameter	17 cm.
Chest	circumference	47 cm.
Abdominal	circumference	48 cm.

FIG. 1. Lateral roentgenogram of skull showing enlargement of vault, thickening of parietal bone, thinning of inner table, practically complete absence of the outer table, and characteristic striated appearance of diploë.

The sclerae were bluish white and conjunctivae pale; otherwise the eyes were normal; pupils reacted to light and accommodated. The ears were normal; hearing was normal. The nose was saddle-shaped. The face appeared normal in contour. The mucous membranes of the mouth were pale. The palate was normal; only 4 teeth were erupted.

Except for a few small cervical glands there was no lymphadenopathy.

The configuration of the chest was quite normal and showed no evidence of either rachitic rosary or a Harrison's sulcus. The heart and lung findings were normal. The abdomen protruded (pot-belly) and there was a small umbilical hernia. The liver was not enlarged. The spleen could be palpated about two finger breadths below the costal margin and was in a lateral position. The edge was sharp and firm.

The extremities were negative. There was no evidence of epiphyseal thickenings.

The genitalia were negative.

There were no neurological findings.

While under observation the child was confined to its home with an attack of acute parotitis with an uneventful course.

Laboratory Findings. On repeated blood examinations the hemoglobin averaged 34 per cent (Sahli); the red blood cells ranged from 1,830,000 to 3,390,000. A marked degree of anisocytosis, poikilocytosis and polychromatophilia were always found. The white cell count ranged from 10,200 to 15,100, with an average lymphocyte count of 60 per cent. On one occasion there were 2 per cent myelocytic cells with 3 per cent basophilic polymorphous leucocytes. The blood platelet count was 144,570. Coagulation time was two minutes and bleeding time was five minutes. There were no nucleated red cells.

The Wassermann reaction was negative.

Fragility Test:

		Patient	Control
1	.28	####	####
2	.30	####	####
3	.32	####	####
4	.34	####	###
5	.36	###	##
6	.38	##	#
7	.40	#	0
8	.42	#	0
9	.44	#	0
10	.46	#	0
11	.48	0	0
12	.50	0	0

Van den Berg: Direct and indirect were negative.

Urinalysis: Negative. No evidence of urobilinogen.

Repeated studies for sickle cells in fresh preparations, saline dilutions of blood, incubated and unincubated, at six, twelve and twenty-four hour intervals were made, but all were negative.

Roentgen Findings. The entire skeleton was studied—all the bones were essentially negative except for the skull which presented a strikingly characteristic aspect. The cranium was enlarged in all its diameters and was considerably out of proportion to the facial bones which presented an appearance entirely normal for a child of this age. Only the parietal bones showed some very distinctive changes. The inner tables of these bones were thinned out

considerably yet sharply delineated. The outer tables could, for the most part, not be distinguished. The normal diploë was replaced by a finely striated structure, the markings of which ran perpendicular to the inner table.

Both parietal bones were very much thickened; this thickening was most pronounced in the regions of the parietal bossae and tapered off toward the suture junctions. The frontal bone showed considerable thickening but no striations. In the lateral view the frontal bone protruded corresponding to the tumescence observed clinically. The sella was of normal size and configuration. A study of the skull in various views disclosed no synostoses (see Figs. 1 and 2).

DISCUSSION OF CASE

Although the roentgenogram of the skull of the case we are reporting is identical with that described for erythroblastic and sickle cell anemia, it is not sufficient evidence to support a diagnosis of either disease. The occurrence in a colored child would tend toward a diagnosis of sickle cell anemia, but the failure to find sickle cells in the circulating blood does not permit such a diagnosis.

Except for a single instance in which a mulatto child was affected, all the cases of erythroblastic anemia reported to date have occurred among white children of either Greek or Italian parentage. There is no instance of the occurrence of this condition in a negro child. The absence of splenic enlargement, evidence of hemolysis or normoblasts in the circulating blood stream should preclude the likelihood of a diagnosis of erythroblastic anemia in this case.

From the evidence at hand it would seem that the skull changes illustrated by our patient occur in hemolytic anemia. But both the laboratory and clinical findings of this patient during the period of observation were insufficient to classify this case as one of hemolytic anemia. There was no evidence of jaundice clinically and no proof of hemolysis by the laboratory tests. The only positive findings were the anemia of varying degree and the roentgen appearance of the skull. We do not feel that it is possible to definitely include this patient in the hemolytic group of anemia, although the skull findings of this case are identical with those reported for the hemolytic group of anemias.

In searching the literature for references to the peculiar skull changes observed in the case we have reported, we encountered the work of Herbert U. Williams who studied the skulls of ancient Indians. This author presented a roentgenogram of an Indian skull which in appearance was practically identical with that of the case we are reporting. The interest incited through this article led one of us to investigate several hundred skulls of ancient Peruvians, which are part of the collection of the Field Museum of Natural History at Chicago. This material was placed at our disposal through the courtesy of Henry Field, assistant curator at the Museum.

Fig. 2. Posteroanterior roentgenogram of skull of patient. Furrow at the site of sagittal suture can be seen. Characteristic striations are again present.

Eleven skulls of this collection showed an involvement of some degree. We were able to demonstrate that any of the bones of the skull may be involved, but the lesion was most commonly found affecting the supra-

FIG. 3. Photograph from above of ancient Peruvian skull showing porous involvement of parietal and frontal bones with greatest involvement in the region of the bossae. The regions about the suture lines were free. The supraorbital plate of this skull was not involved. The maxilla, sphenoid, zygoma and temporal bones were only slightly affected by the process. The six-year molar of this skull was not erupted, indicating the approximate age of this subject. (Photograph through the courtesy of the Field Museum.)

orbital plates. The degree of involvement was quite variable; in some cases it was barely perceptible, whereas in others almost all the bones of the skull and the face were affected. The appearance is compared by Williams to pumice stone or coral or to fine sponges or moss. The outer table may be altogether wanting, while the cancellous bone of the diploë with enlarged spaces up to 2 mm. or a little more in diameter is level with or protrudes above the general surface.

HEMOLYTIC ICTERUS

Constitutional hemolytic anemia or chronic familial hemolytic icterus refers to a distinct clinical entity, characterized by high grade anemia, icteric pigmentation of the skin and sclerae, but without the presence of bile pigment (bilirubin) in the urine. There is associated both hepatic and splenic enlargement. The outstanding blood findings are the small red cell or microcyte and red cell destruction due to an increased fragility or decreased resistance of these elements. Hayem and Minkowski in 1898 and 1900 respectively, were the first to describe this disease. However, Gänsslen and his associates in 1919 and then again in 1922 and 1925 in a comprehensive study of the familial and congenital tendencies of this condition emphasized how frequently constitutional anomalies came under observation in conjunction with this symptom-complex. To these investigators the occurrence of constitutional deficiencies indicated that hemolytic icterus was only a link in the chain of constitutional inferiority. They pointed out the association with hemolytic icterus of developmental anomalies of the skeletal system (Turmschädel, brachydactylia, syndactylism, polydactyly); the eyes (microphthalmia, heterochromia of the iris); the ears; the skin, and the endocrine glands (genital hypoplasia, hypothyroidism). Among these anomalies, those affecting the skull were the most outstanding. Gänsslen and his associates stressed the frequent occurrence of "Turmschädel" or "tower skull" in cases of familial hemolytic icterus. The syndrome of icterus plus "Turmschädel" has been frequently described by other writers since it was originally mentioned by Gänsslen (Schäfer, Morawitz, Nonnenbruch, Bauer, Naegeli, Mikulowski, and Günther).

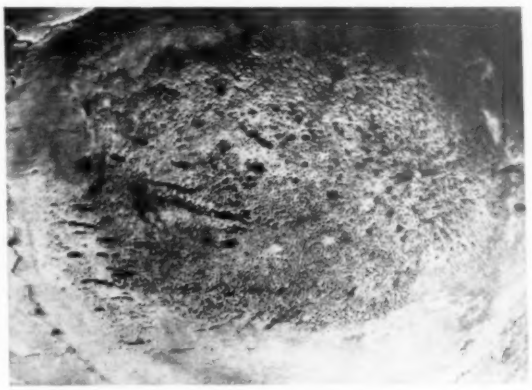

FIG. 4. Enlargement of region of frontal boss of skull shown in Figure 3. The porous nature of the bone is illustrated.

Günther has recently published a very exhaustive study of the subject, "Turmschädel," in which he mentions the association of this condition with hemolytic icterus. This author specifies two chief forms of "Turmschädel:" (1) the cylindrical or turret cranium, (2) the conical or oxycranium. Each type is named after its characteristic configuration. Most writers on this subject ascribe the deformities of "Turmschädel" to a premature synostosis of the cranial sutures, particularly the frontal and frontosphenoidal sutures. This author, however, considers the primary cause to be a disturbance of bone growth of the primordial skull, with possibly also a disturbance of blood vessel distribution, whereas obliteration of the sutures is mentioned only as a secondary factor. Hypoplasia of the base of the skull with compensatory increase in height is the cause. Deformity of the base of the skull results from the hypoplasia. The basilar process is abnormally small.

Hypoplasia of the base was pointed out by Greig as a characteristic symptom of "Turmschädel." The capacity of the skull in most instances is within normal limits because of the associated increase in volume which results through greater development in height of the skull capsule and also through a depression of the base. The degree of depression of the base may vary and can be recognized clinically by the lower position of the external auditory meatus. The ears appear to be set too low. The lateral parts of the petrous bone are only partially involved in this depression. The central part of the skull base, especially in the region of the sella may be displaced downward to an even greater degree than the surrounding parts.

Fig. 5. Posteroanterior roentgenogram of same skull showing striations perpendicular to the inner table, most pronounced in the region of the right parietal boss. (Through the courtesy of the Field Museum.)

Fig. 6. Oblique roentgenogram, posteroanterior view demonstrating striations in parietal region. (Through the courtesy of the Field Museum.)

The lateral roentgenogram illustrates rather typically the deformities as indicated. The characteristic contour of the skull is obvious. The calvarium may be thinned out in its upper and posterior part. The hyperostoses which result from secondary hyperemia may be seen. The most distinctive feature, however, is the depression of the skull base which is recognized by the abnormally deep cerebral fossae. This is particularly true of the middle fossa. As a result, the sella shows an abnormally deep position. The appearance of the sella varies. It may be entirely normal. On the other

hand, it may be deformed, enlarged, smaller, or widened. Sometimes as a result of compression the anterior and posterior clinoidal processes can touch. The body of the sphenoid is compressed and the sphenoidal sinuses are small or may be entirely lacking.

The anterior fossa is considerably shortened by the vertical position of the orbital plate of the frontal and the lesser sphenoidal wing. This encroaches upon the orbital cavities and decreases their depth. Protrusio bulbi, which is a clinical feature of "Turmschädel," results. The frontal sinuses are smaller or entirely lacking.

In the posterior fossa, except for its depth and shortness, there are no outstanding findings.

In the anteroposterior views we can recognize a short and narrow superior orbital fissure. In this same view the cribriform plates can be recognized as a deep depression between the high jutting orbital plates.

Günther believes that although the presence of digital impressions is stressed by roentgenologists, they are of no special significance. They may or may not be present. Some authors even contend that they are not a result of increased intracranial pressure.

The frontal, frontosphenoidal and coronal sutures may be synostosed, but the lambdoid suture is usually open.

Vogt and Diamond, in a roentgenological consideration of the congenital anemias, stated that they had observed 5 cases of congenital hemolytic icterus, 13 cases of erythroblastic anemia and one case of sickle cell anemia with distinctive bone changes in the roentgenogram. No case reports and no data regarding the blood findings were offered. These authors stated further that the same bone changes may be present in each of the three forms of anemia reported, but usually to a lesser degree in hemolytic icterus and sickle cell anemia than in erythroblastic anemia. Sherwood Moore, in discussing the report of these authors, disagreed with them in grouping together congenital hemolytic icterus and sickle cell anemia. He stated further that as far as roentgen changes in the bones constitute a guide for differentiation, the two diseases are distinct.

The observations of Vogt and Diamond are particularly interesting in comparison with the reports of the European investigators who mention "Turmschädel" as part of the syndrome of hemolytic icterus. The skull changes in tower skull differ so greatly from the thickened, striated skull appearance indicated by the American writers, that it would be valuable to determine whether either skull appearance may be part of the syndrome of hemolytic icterus and if so, to study the particular significance each might have.

SUMMARY AND CONCLUSIONS

(1) Erythroblastic anemia is characterized by definite bone changes.

(2) The skull changes in erythroblastic anemia are quite typical. The very thin or absent outer table, the thin inner table and the thickened diploë which presents a striated appearance, offers a very striking picture.

(3) The long bones also show very pronounced changes in erythroblastic anemia, as do other bones of the skeleton.

(4) Skull changes similar to those reported for erythroblastic anemia have been observed in cases of sickle cell anemia.

(5) No definite conclusions can be drawn from the literature regarding changes in the long bones in sickle cell anemia.

(6) A case of a colored child is presented having skull changes identical with those described for both erythroblastic and sickle cell anemia, but no changes in the long bones were observed. The blood picture showed no normoblasts. Sickle cells were also not observed.

(7) The skull changes described are indicative of a hemolytic process, but are not pathognomonic for either erythroblastic anemia or sickle cell anemia.

(8) A similar roentgenogram is reported for some skulls of ancient Peruvian Indians.

(9) The occurrence of "Turmschädel" or "tower skull" has been frequently described in cases of hemolytic icterus.

(10) In "Turmschädel" the cranial tables are not involved. The characteristic deformity in "Turmschädel" results primarily from a hypoplasia of the base and secondarily from premature synostoses.

(11) "Turmschädel" is not pathognomonic for hemolytic icterus, but its high incidence in this condition should make it a valuable adjunct in the diagnosis of this disease.

(12) The roentgenogram shows characteristic deformities in "Turmschädel."

NOTE: Since this paper was submitted for publication, Koch and Shapiro[16a] have summarized from the literature 18 cases of erythroblastic anemia with bone changes to which they added 5 case reports of their own. These authors pointed out that the roentgenographic findings associated with erythroblastic anemia are not typical of this disease alone but seem to be characteristic of the three hemolytic anemias: familial icterus, sickle cell anemia and erythroblastic anemia. Simultaneously with the report of these authors appeared a communication by Whipple and Bradford[29a] on "Racial or Familial Anemia of Children." These authors reported 3 cases of erythroblastic anemia with detailed pathologic findings in which they pointed out typical changes in the bone marrow and pigment abnormalities. They state, "The changes in the bone we cannot believe are simply an adaptive reaction to marrow hyperplasia, but we suggest that these abnormalities may be due in part to some fundamental metabolic disturbance of the order of the abnormalities of the bone in scurvy or acromegaly."

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TUBERCULOUS PERICARDITIS*

ITS ROENTGENOLOGIC SIGNIFICANCE

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THE roentgenologic diagnosis of diseases of the pericardium is, for the most part, limited to the recognition of pericardial effusions. Adhesive pericarditis is less frequently detected. The roentgenologist gives but little if any thought to the etiology of the pericardial disease, this being considered the exclusive province of the clinician. Thus the reason becomes apparent for the almost complete absence of any reference in the literature to the roentgenologic aspects of tuberculous pericarditis. Our experience in the study of 17 cases of tuberculous pericarditis at the Philadelphia General Hospital has shown that the roentgen examination is one of the important procedures to be resorted to in the study of this condition. In several cases this examination afforded the first intimation as to the tuberculous nature of the pericardial disease. It is for this reason that the roentgenologist should have some knowledge regarding this condition.

It should be recognized that frequently the roentgen manifestations are not, in themselves, sufficiently characteristic to warrant a positive diagnosis of tuberculous pericarditis. The condition may be suspected but it is only after careful correlation with the clinical aspects of the case that the diagnosis can be made. It becomes essential, therefore, that the roentgenologist possess some knowledge regarding the clinical aspects of this condition and it is for this reason that a few case reports are given and a brief reference is made to pertinent facts regarding the incidence, pathology and symptomatology of tuberculous pericarditis.

CASE REPORTS

CASE 1. M. T., a colored female, aged thirty-eight, was admitted to the Philadelphia General Hospital on August 16, 1931, with a chief complaint of dyspnea. The symptoms started acutely two days before with chilliness, swelling of the face, neck, arms and breasts. The temperature was 101°F., pulse 110 and respirations 55 a minute. The patient had had previous admissions with somewhat similar symptoms. The onset of her illness dated back to July, 1929. She had had a roentgen examination of her chest made in March, 1931 (Fig. 1), which revealed some generalized enlargement of the cardiac silhouette and some widening of the superior mediastinal shadow. The lungs were negative. The cause of the enlargement of the heart was not recognized at that time. An enlarged lymph gland removed from the right side of the neck was reported as "chronic proliferative lymphadenitis, no evidence of tuberculosis." The physical examination revealed an enlargement of both breasts, especially the right. There were numerous distended veins over the right neck, chest and abdomen. The heart was enlarged to the left and there was evidence of aortic dilatation. A rough systolic murmur could be heard over the mitral area. Laboratory studies were negative. The symptoms and physical findings were regarded as evidence of mediastinal pressure and led to a clinical diagnosis of a luetic aortitis with aneurysm or mediastinal tumor.

A roentgen examination in August, 1931 (Fig. 2), revealed a marked enlargement of the cardiac silhouette and a widening of the superior mediastinum (compare with Fig. 1). Roentgenoscopically there was absolutely no pulsation of the heart or great vessels. On deep inspiration instead of the usual descent of the apex of the heart with the diaphragm there was noted a slight but definite upward tug. The lungs were again negative. A roentgen diagnosis

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was made of "adhesive pericarditis, probably tuberculous in nature." A total of 300 c.c. of blood-tinged fluid was withdrawn from the pericardial sac and 400 c.c. of air was injected. A roentgenogram of the pneumopericardium (Fig. 3) revealed the heart to be very small with adhesions about the base.

The patient subsequently developed a bilateral pleural effusion, her condition became progressively worse and she died on September 24, 1931.

Autopsy revealed a chronic fibrinous pericarditis. The lumen of the superior vena cava where it entered the right auricle was almost completely obliterated by the adhesions of the pericardium. The pulmonary artery and aorta were also somewhat constricted. Nothing of note was found in any of the other organs. Microscopic study of the pericardium revealed the tuberculous nature of the disease. Injection of the pericardial fluid into a guinea pig was positive for tuberculosis.

Comment: The constriction of the great vessels by the pericardial adhesions was responsible for the symptoms and signs of mediastinal pressure.

FIG. 1. Case I. This examination of the chest in March, 1931, showed no evidence of pulmonary tuberculosis. Some enlargement of the heart and widening of the supracardiac shadow was noted, but the significance of these findings was not appreciated at the time.

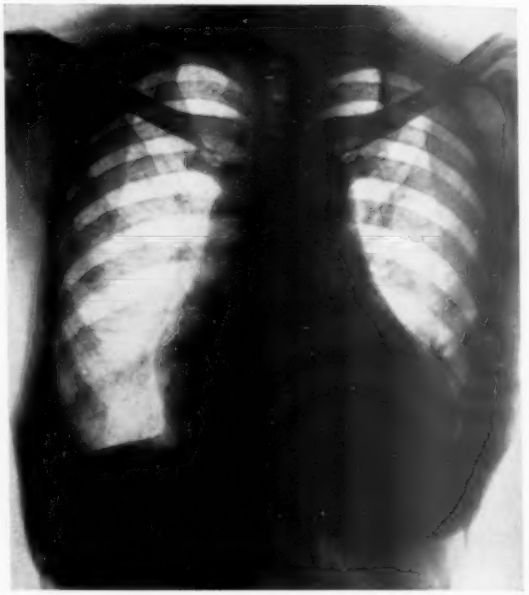

FIG. 2. Case I. An examination of the chest in August, 1931, revealed considerable increase in size of the cardiac silhouette since the previous examination in March. The lungs were again negative. From the appearance of the heart shadow and the roentgenoscopic observation, a roentgen diagnosis was made of "adhesive pericarditis, probably tuberculous."

CASE II.* D. S., a white male, aged forty-six, was admitted on February 23, 1931, complaining of cough and general weakness of about three months' duration. Examination revealed the patient to be anemic and emaciated, but not acutely ill. Bronchovesicular breathing with numerous crepitant râles was heard over the left base, and over the entire right lung. The heart was markedly enlarged, the sounds were distant, of poor quality and no murmurs were audible. The blood pressure was 100/80; temperature 98.6°F., pulse 100, respirations 30. Laboratory studies were negative. The clinical impressions were: possible pulmonary tuberculosis, pericarditis with effusion and right-sided pleural effusion.

Roentgen examination (Fig. 4) revealed a chronic ulcerative tuberculosis involving the right lung and a less extensive but similar lesion in the left upper lobe. There was obscuration of the right costophrenic sulcus, probably due to a small pleural effusion. The heart was markedly enlarged with increase in width of the supracardiac shadow. Roentgenoscopically

* This case was previously reported by Dr. Thomas Klein.

there was no evidence of any pulsations. The supracardiac shadow did not change with change in position of the patient. The roentgen diagnosis was "probable tuberculous pericarditis." The production of a pneumopericardium was recommended.

The pericardial sac was repeatedly aspirated and quantities of fluid ranging from 15 to 1,180 c.c. were removed. In a period of two months approximately 4,000 c.c. were removed. It was usually straw-colored and turbid, never hemorrhagic. The effusion showed tubercle bacilli.

Fig. 3. Case 1. After the removal of fluid from the pericardial sac and the injection of air, this roentgenogram showing the hydro-pneumopericardium was obtained. Note the small size of the heart and the density about the base of the heart due to the presence of adhesions.

Varying quantities of air were injected into the pericardial sac following aspiration. Figures 5 and 6 show the pneumo-hydropericardium on one such occasion. This examination revealed the small size of the heart and the evidences of adhesions about the base of the heart. There was always an accompanying pleural effusion which showed a tendency to loculation.

In spite of various forms of treatment the patient's condition became progressively worse and he died on June 1, 1931.

Autopsy revealed a tuberculous pericarditis with effusion and beginning adhesions, tuberculosis of the lungs, hypostatic pneumonia, miliary tuberculosis of the spleen and kidneys.

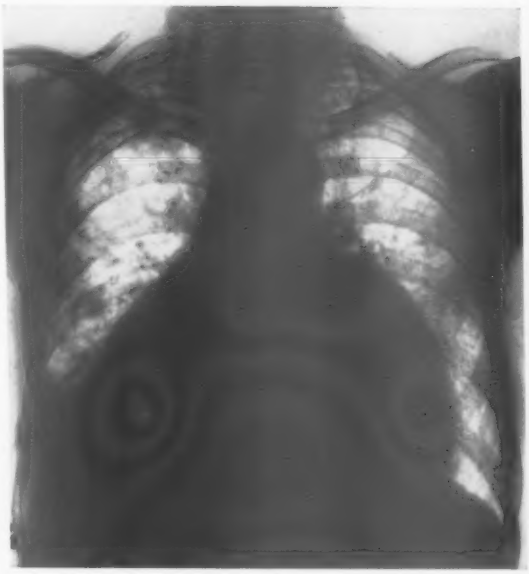

Fig. 4. Case 11. Roentgen examination of the chest shows extensive bilateral pulmonary tuberculosis. The cardiac silhouette is markedly enlarged. The supracardiac shadow is comparatively narrow. Roentgenoscopically there was no evidence of cardiac pulsations. The roentgen diagnosis was "probable tuberculous pericarditis."

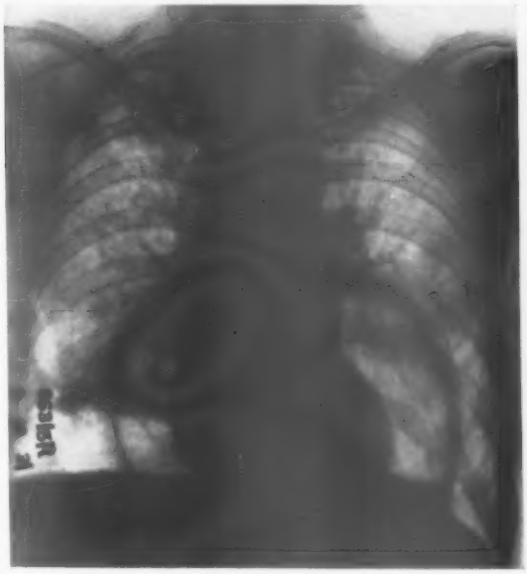

Fig. 5. Case 11. The chest after the production of a pneumopericardium. Note the small size of the heart.

FIG. 6. Case II. Lateral view of the pneumopericardium. Note the displacement of the heart away from the anterior chest wall.

CASE III. C. J., a colored male, aged sixteen, was admitted to the Men's Tuberculosis Ward on March 11, 1930, complaining of pain in the chest, cough and dyspnea. He had been ill for about three months. Examination showed the patient to be toxic and restless. The cervical glands were enlarged. The cardiac dullness was markedly increased in the transverse diameter. The heart sounds were distant and of poor quality; no thrills or murmurs were detected. The temperature on admission was 102°F., pulse 130, respirations 30 per minute. Laboratory studies were negative.

Roentgen examination (Fig. 7) showed the cardiac silhouette to be markedly enlarged with a marked increase in the width of the supra-

FIG. 7. Case III. Roentgenogram of chest at the time of admission. The lungs were negative for tuberculosis. There was a marked enlargement of the cardiac shadow showing the characteristic pyramidal shape of a pericardial effusion. Roentgenoscopically there were no pulsations to be seen. The roentgen diagnosis was "tuberculous pericarditis."

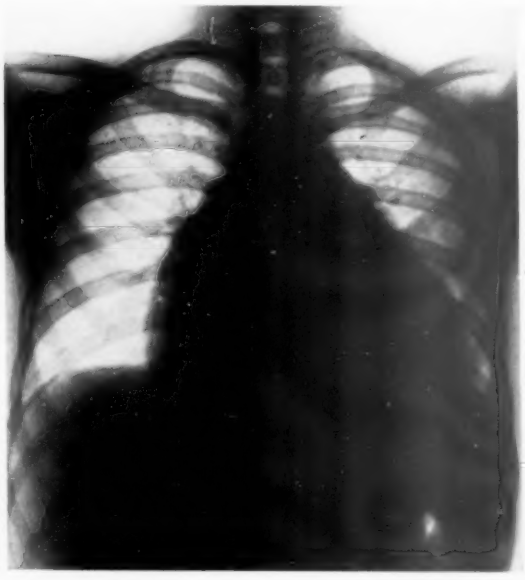

FIG. 8. Case III. An examination made five weeks later shows a definite increase in the size of the cardiac silhouette. The lungs are again negative.

cardiac shadow. The lungs showed no evidence of tuberculosis. Roentgenoscopically there was noted an absence of cardiac pulsations. The cardiac shadow did not change in contour when the patient was examined in the recumbent position. Diagnosis: "Tuberculous pericarditis."

A second roentgen examination made five weeks later gave the appearance shown in Figure 8. There has been a definite increase in the size of the cardiac shadow. The lungs were again negative for tuberculosis.

Aspirations of the pericardium did not bring fluid. The patient's condition improved somewhat and he was discharged on June 8, 1930,

Fig. 9. Case III. The chest six months later showing the marked enlargement of the cardiac shadow. Although the appearance is that of a massive pericardial effusion, at autopsy it was found that the increase in the size of the heart shadow was primarily due to a marked thickening of the pericardium.

only to be readmitted with essentially the same complaints eleven days later. During this admission the area of cardiac dullness continued to increase in size. On July 28, 1930, pericardial aspiration yielded 8 c.c. of a thick, greenish, apparently purulent material which contained tubercle bacilli. On September 8, 1930, a pericardotomy was done. No free fluid or pus was found. Firm adhesions connecting the visceral and parietal pericardium were found creating numerous loculations. These could not be extensively broken up and the wound was closed with drainage.

A roentgen examination made in October (Fig. 9) shows the progressive enlargement that occurred in the size of the cardiac silhouette.

The patient's condition grew gradually worse, evidence of congestive failure appeared and death occurred on November 4, 1930.

Autopsy Findings. On opening the pericardial sac a great deal of thick, caseous, purulent material exuded from the opening. Many dense adhesions between the pericardium and the epicardium reduced the sac to a series of multiloculated cavities. The lining of the pericardial sac was composed of a gray, caseous, necrotic tissue, markedly thickened, measuring from 0.75 to 1.5 cm. in thickness. The weight of the entire heart and pericardium was 2,000 grams.

Case IV. D. T., a colored female, aged eleven, was admitted on September 23, 1931, complaining of pains in the chest, cough, dyspnea, anorexia and marked weakness. These symptoms had been present for two weeks although the patient had not felt well for a month. On admission the patient was quite dyspneic and appeared acutely ill. The respirations were rapid, shallow and abdominal in type. The cardiac dullness was markedly increased in the transverse diameter. The heart sounds were distant and rapid; no murmurs were audible. A pulsus paradoxus was present. The abdomen was distended and very tender to touch, and the liver edge was palpable at the umbilicus. There was no edema of the extremities.

A roentgen examination of the chest on the day of admission (Fig. 10) revealed a marked enlargement of the transverse diameter of the cardiac shadow. Roentgenoscopically there was no evidence of any pulsations and there was no change in the cardiac shadow with change of position of the patient. The diagnosis was: "Pericarditis with effusion."

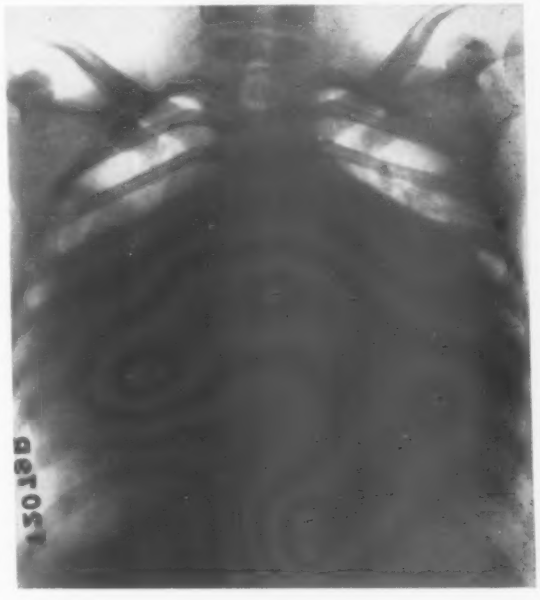

Fig. 10. Case IV. A massive pericardial effusion due to tuberculous pericarditis. No pulmonary involvement. At autopsy 2,500 c.c. of fluid was obtained from the pericardial sac.

The clinical diagnosis was: "Pericardial effusion, probably tuberculous." Pericardial tap revealed bloody fluid. The patient was in very poor condition on admission. Her condition became progressively worse and she died a few days later.

At autopsy there was found a serofibrinous tuberculous pericarditis with an enormous effusion (2,500 c.c.). The heart was normal in size; the mitral and aortic valves were normal and the heart muscle showed no abnormalities, except for moderate dilatation. The mediastinal lymph nodes were enlarged and caseous. The lungs were free of any tuberculous involvement. There was miliary tuberculosis of the spleen, kidneys, liver and gastrointestinal tract.

INCIDENCE

Tuberculous pericarditis is not often recognized clinically and for this reason is regarded as an uncommon disease. At postmortem examination, however, where the condition is not an infrequent finding, the true incidence of the disease can be ascertained. The incidence as variously given by different writers is somewhat less than 1 per cent. In our own series of cases the condition occurred in 0.9 per cent of all autopsies performed in the two-year period during which this study was made. It has been estimated that tuberculous involvement of the pericardium occurs in 4 per cent of all tuberculous patients. The condition may occur at any age; it is equally as common in males as females and shows a decided preference for the colored race.

PATHOLOGY

It is generally recognized that the pericardium may become involved by tuberculosis in one of three ways: (1) by way of the blood stream, (2) by way of the lymphatics and (3) by direct extension from a focus in an adjacent organ. The hematogenous route is probably the least common. This method of involvement frequently occurs in the course of a generalized miliary tuberculosis and as such is rarely recognized clinically. The most common mode of involvement is from some neighboring structure as the lung, pleura or tracheobronchial glands. This may be by way of the lymphatics or by direct extension. Pericardial involvement as an extension from a tuberculous mediastinitis occurred in several cases reported by one of us.

The term "clinically primary tuberculous pericarditis" is applied to those cases in which no tuberculous involvement can be demonstrated elsewhere in the body during the life of the patient. Such cases are not infrequent. Six of this series were of this type. In these, the pericardial disease constituted the entire cause of the patients' illness. Under such circumstances the tuberculous nature of the disease is often difficult to establish. A true primary involvement of the pericardium in which no other organs can be found affected by careful histological search is conceded as possible by a number of writers. Such involvement probably occurs either through the blood stream or by way of the lymphatics. This form of the disease must be extremely rare and absolute proof of its primary nature is difficult to establish. No cases of this kind were encountered in this series.

Pathologically, tuberculous pericarditis may occur in three forms: (1) as miliary tubercles scattered over the various surfaces of the pericardium; (2) as an adhesive pericarditis, and (3) as an exudative pericarditis or pericarditis with effusion. Of these, the first is the least important and, as has been mentioned, occurs as a part of a generalized miliary tuberculosis.

The adhesive form is the most common variety observed at autopsy. Clinically, however, the exudative type is more frequent, since the adhesive variety is seldom recognized. When tuberculosis involves the pericardium, it is characterized by the same tendency as is shown by this disease in other organs, namely, the tendency to form fibrous tissue. This is manifested by the formation of adhesions which are present to some extent in almost every case. This is an important fact from the standpoint of differential diagnosis, since in the demonstration, either clinically or roentgenologi-

cally, of an adhesive pericarditis, tuberculosis must be considered as a possible etiological factor.

In the adhesive variety there may be a marked thickening of the layers of the pericardium, not infrequently to the extent of a centimeter or more. In Case III the pericardium was 1.5 cm. thick. The layers of the pericardium may become adherent to each other, producing complete obliteration of the pericardial cavity. More commonly dense adhesions form locally in various parts of the pericardial sac. Such adhesions are prone to occur at the base of the heart and about the great vessels. They may extend outward to involve the mediastinal structures, the pleura and diaphram. Such adhesions are often responsible for the symptoms complained of and may be at times a distinct aid in the roentgenologic recognition of the pericardial disease.

The third pathological variety characterized by the formation of an exudate is clinically the most important because it is the one most readily recognized and the one most likely to give rise to symptoms. The exudate may be either serous, serofibrinous, purulent or hemorrhagic. The exudative variety quite often terminates as an adhesive or obliterative pericarditis. This evidently occurred in Case III. The amount of fluid present may vary considerably. Some of the largest effusions on record have been encountered in this disease and amounts up to 4,000 c.c. have been reported. In Case IV 2,500 c.c. of fluid was found at autopsy. In the case of purulent exudates inspissation may occur and subsequently calcium be deposited. The same process may take place in the extensive caseation that occurs in the thickened pericardium. The demonstration of calcification of the pericardium roentgenologically should suggest the possibility of a tuberculous pericarditis, although other factors may have been causative of its production.

SYMPTOMATOLOGY

The symptomatology of tuberculous pericarditis presents nothing characteristic. The symptoms may vary considerably in their nature and severity and are often overshadowed by the manifestations of associated conditions such as an active pulmonary tuberculosis or a miliary tuberculosis. The adhesive variety may give rise to very few symptoms unless the adhesions are quite extensive or of a considerable thickness. Under such circumstances symptoms referable to an embarrassed circulation may be elicited. This is well illustrated in Case III.

Symptoms in the exudative type of the disease are usually more pronounced. The onset, as a rule, is quite insidious and symptoms may not be present or very marked until an effusion of considerable proportion develops. Usually there is some general malaise, weakness and loss of weight. The majority of our cases showed a moderate elevation of temperature ranging from 99° to 103° F. Pain is not a prominent symptom, being present in only one-third of our cases. Most patients show a definite increase in the pulse rate. Dyspnea is probably the most outstanding and most constant symptom. This is out of proportion to the lung changes to be found. It becomes progressively more marked with an increase in the amount of the effusion. Various cardiac symptoms are frequently present and in the later stages of the disease, evidences of decompensation may dominate the clinical picture. In many cases, however, the terminal symptoms are those of a miliary tuberculosis.

PHYSICAL EXAMINATION

Physical signs are principally found in the exudative type of the disease. The presence of a friction rub early in the course of the disease with subsequent enlargement of the area of cardiac and supracardiac dullness is a more or less constant finding. The apex beat is usually invisible and on auscultation the heart sounds are indistinct and muffled and occasionally practically entirely absent. Murmurs, if present, are usually systolic in time and functional in character. Organic cardiac murmurs are rarely

encountered in tuberculous pericarditis. This is a point of considerable diagnostic value as it helps to differentiate this condition from others, especially rheumatic heart disease, with which it is likely to be confused. Depression of the diaphragm and left lobe of the liver can occasionally be made out. The physical signs of pulmonary tuberculosis should be looked for. There is, not uncommonly, an associated pleural effusion and less frequently ascites, thus giving rise to a tuberculous polyserositis. Peripheral edema is found in a certain number of instances, usually in far advanced cases. This cannot always be attributed to cardiac failure. It may be confined exclusively to the neck, face and arms, the result of constriction of the large veins at the base of the heart by pericardial adhesions. This may also produce considerable distention of the cutaneous veins drained by the constricted vessels. This feature is well illustrated in Case 1.

LABORATORY STUDIES

Of the various laboratory examinations, study of the pericardial fluid is by far the most important. Whenever a tuberculous pericardial effusion is suspected paracentesis should be done. Hemorrhagic fluid is strongly suggestive of tuberculous pericarditis. The presence of adhesions in this type of pericardial disease not infrequently produces a loculation of the fluid so that upon aspiration only a small amount of fluid is obtained in a case presenting evidence of a considerable fluid accumulation. Search of the pericardial fluid for tubercle bacilli should be made in every case as it frequently contains viable organisms. The bacilli are rarely found by smear or culture; usually guinea pig inoculation must be resorted to. Examinations of the sputum for tubercle bacilli are also indicated. While the blood picture shows nothing that can be regarded as characteristic, a leucopenia in the presence of suggestive clinical findings would be in favor of a tuberculous etiology.

ROENTGENOLOGIC ASPECTS

The roentgen examination of the chest is one of the important procedures to be employed in the diagnosis of tuberculous pericarditis. The problem confronting the roentgenologist is first, the detection of the pericardial disease, and secondly, the recognition of its tuberculous nature.

As has been noted, clinically the exudative type of the disease is the one most frequently recognized. Likewise roentgenologically it is also this variety which attracts the attention of the roentgenologist. For this reason the exudative type will be considered first. The recognition of a pericardial effusion by the roentgen examination is not always a simple matter. If the effusion is considerable in amount its detection usually affords but little difficulty. The marked enlargement of the cardiac silhouette, the rather characteristic pyramidal or water bottle shape, and the absence of pulsations when examined roentgenoscopically make its recognition comparatively easy.

With lesser amounts of fluid the diagnosis becomes increasingly more difficult and affords a real problem for the roentgenologist. In moderate-sized effusions the cardiac shadow may present the pear shape frequently referred to as characteristic. Effusions of this amount must be differentiated from enlargements of the heart. For this purpose reliance must be placed upon the character of the pulsations and the effect of change of position of the patient on the shape of the cardiac shadow. In pericardial effusions of moderate size the cardiac pulsations are generally definitely decreased, rarely absent as in the very large effusions. This diminution in pulsation is in distinct contrast to the marked pulsations usually seen in cardiac enlargements due to hypertrophy. If the cardiac enlargement is due to dilatation, however, the pulsations will also be diminished and will not aid, therefore, in the differential diagnosis. In pericardial effusion, especially if moderate in amount, there will be noted a definite change in shape of the cardiac shadow with

change in position of the patient. This does not occur in enlargement of the heart. Holmes regarded this as a very important sign of pericardial effusion and was of the opinion that it did not occur in any other condition.

In small effusions within the pericardium, the roentgenologic recognition of the condition is extremely difficult. The roentgen appearance in cases of small effusions, less than 200 c.c. is not sufficiently characteristic to permit of its recognition. When the opportunity is afforded to examine serially a case of developing pericardial effusion, the changes occurring in the cardiac silhouette are usually sufficiently characteristic to make its recognition possible. The more or less rapid enlargement of the cardiac shadow with a distinct bulge to the right, the accompanying increase in the width of the supracardiac shadow, the straightening of the left border of the heart in the region of the auricular curve and the gradual development of the pear shape are indicative of a developing pericardial effusion.

Having determined the presence of pericardial disease in the form of a pericarditis with effusion, the next problem is the recognition of its tuberculous nature. Attention should first be directed to the lungs to detect the presence of pulmonary tuberculosis. A pericardial effusion associated with active pulmonary tuberculosis, is, in the majority of instances, tuberculous in nature. While the pulmonary disease is often extensive and active, this is not necessarily the case. The finding of an enlarged cardiac shadow in association with pulmonary tuberculosis should lead one to suspect the possibility of a tuberculous involvement of the pericardium, since, as is traditionally known, individuals with pulmonary tuberculosis usually have small hearts. One would, of course, have to exclude other causes for enlargement of the heart which occasionally occur in tuberculous patients. In children and occasionally in adults the only evidence of tuberculosis may be the presence of enlarged tracheobronchial glands. If these can be recognized as tuberculous, an associated pericardial effusion should be suspected also as being tuberculous. Furthermore, the recognition of tuberculosis anywhere in the body, such as a cervical adenitis or a spondylitis should again point to tuberculosis as a possible cause of the pericardial disease.

In the absence of tuberculosis elsewhere in the body, the roentgenologic recognition of the tuberculous nature of a pericardial effusion becomes somewhat more difficult. The demonstration of pericardial adhesions should lead one to consider the possibility of tuberculosis because, as we have seen, adhesions, especially at the base of the heart, are an almost invariable accompaniment of this disease. If the adhesions at the base are sufficiently dense, they will prevent this portion of the pericardial sac from distending with fluid; thus the supracardiac shadow will be quite narrow in contrast to the definite widening noted in most instances of pericardial effusion. Furthermore, with the patient in the recumbent posture adhesions at the base prevent the supracardiac shadow from widening as ordinarily occurs when adhesions are not present. While this feature may be present in pericardial effusion of rheumatic origin, we have observed this most characteristically in the tuberculous type where the adhesive process begins in and often remains localized at the base for a long period of time. These points are well illustrated in Case 1.

The adhesions are not necessarily confined to the pericardium but may extend beyond to involve neighboring structures. Not infrequently the mediastinum is affected, especially that portion adjacent to the base of the heart. Adhesions here tend to fix the heart and prevent the alteration in the shape of this organ which normally occurs on deep inspiration and expiration. In some patients there may actually occur a slight but definite upward tug of the heart on full inspiration as was observed in Case 1. When the adhesions involve the diaphragm this may be recognized by al-

terations in its contour and restrictions in the motion of its medial portion. Usually there are also associated pleural adhesions which may manifest themselves roentgenoscopically. Although the roentgen appearance of the cardiac silhouette may be that of an effusion, attention is called to the fact that the same appearance can be produced by a marked thickening of the layers of the pericardium as occurred in Case III. In such cases there will be noted a complete absence of the cardiac pulsations and almost complete fixation of the heart.

When tuberculosis is suspected as the cause of a pericardial effusion, air introduced into the pericardium after the withdrawal of the fluid will demonstrate the actual size of the heart, as seen on the roentgenogram. The finding of a small heart is in favor of the tuberculous nature of the disease. A large heart does not, of course, exclude tuberculosis. The production of a pneumopericardium will, at times, also aid in the roentgenologic demonstration of adhesions. This is well shown in Case I. It will be noted in Figures 2 and 3 that no change occurred in the appearance of the supracardiac shadow after the withdrawal of the fluid. This was due to adhesions about the base of the heart as was demonstrated at autopsy.

In the adhesive variety of tuberculous pericarditis, the diagnostic difficulties are materially increased. The roentgenologic recognition of pericardial disease in such cases depends upon the detection of pericardial adhesions. Needless to say, the recognition of an adhesive pericarditis does not establish tuberculosis as the etiological factor. If associated with tuberculosis elsewhere or if no other adequate cause for the condition can be found, tuberculosis should be suspected.

The proper interpretation of the roentgenologic findings in tuberculous pericarditis, as in many other conditions, depends, in a large measure, upon a careful consideration of the clinical manifestations of the case. If these are in harmony with the possibility of tuberculous pericarditis such a diagnosis becomes justifiable. When the clinical data are insufficient or not at hand, the possibility of tuberculous pericarditis should be suggested to the clinician, unless the pericardial disease is obviously not tuberculous. Upon such suggestion, the clinician can resort to those procedures which will establish or exclude such a diagnosis.

To summarize, therefore, the roentgenologic diagnosis of tuberculous pericarditis depends first, upon the recognition of pericardial disease; secondly, upon the detection of pericardial adhesions; thirdly, upon the demonstration of tuberculosis of the lungs or elsewhere in the body, and finally, upon correlation with clinical data compatible with the diagnosis of tuberculous pericarditis.

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VARIETIES OF FUSOSPIROCHETAL DISEASE OF THE LUNG*

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NUMEROUS articles upon fusospirochetal disease of the lower respiratory passages have appeared in the literature within the past few years. These have dealt with various phases of the problem such as the bacteriology, the pathology, experimental and clinical, the treatment and the rôle this infection plays in the causation of lung abscess and gangrene. These articles have been written by those engaged in research work, clinicians and pathologists and others engaged largely in the care of the tuberculous. There has been little written on the subject by those who are general internists and those who come in contact with a large number of patients with various respiratory involvements. Little attention has been paid to the subject by roentgenologists. Though the evidence seems conclusive that many forms of respiratory disease have this common etiology and are in reality part of the same disease with varying manifestations, such recognition by medical men generally seems as yet rather tardy. It therefore seems not amiss to draw to the attention of roentgenologists a wide variety of lesions that have been proved to have a common bacteriological etiology. The roentgenologist often makes an examination before various forms of laboratory investigations have been made; he is often called upon to express an opinion without other data, such as clinical or laboratory findings. He must therefore bear in mind the different lesions that this disease may manifest, as well as its rather common occurrence, so that he can be on his guard against calling a beginning abscess—pneumonia or a pulmonitis—tuberculosis.

Pulmonary spirochetosis was considered a tropical disease until 1918 when Voille discovered the condition in the military and civil population of France. Since then many cases have been reported from all parts of the world. Until 1929, however, only about 150 cases had been reported in the literature. Since then this number has been greatly increased. As early as 1867, Leyden and Jaffe[16] discovered spirochetes in the sputum in cases of putrid bronchitis and at necropsy in 2 cases of pulmonary gangrene. Rona,[20] in 1905, duplicated the report of Leyden and Jaffe, but the importance of these reports was not recognized until Castellani's communication[3] in 1906. He reported 2 cases that seemingly were suffering from tuberculosis but whose sputum failed to reveal any tubercle bacilli, but on numerous examinations showed many spirochetes, and he terms these cases "bronchial spirochaetosis." Johnson[9] in this country reported the first cases in 1909. Two patients, negroes, had acute attacks and made spontaneous recoveries. Since then Smith,[23] Pilot and Davis,[18] Kline,[11] Lewis,[14] Bethune,[1] and others, have made many valuable observations on incidence, pathology, symptoms and therapy of this condition. As an illustration of the rather tardy recognition that spirochetes play an important part in respiratory infections we wish to call attention to an article on "Lung Abscess" by G. J. Heuer in Blumer's "Bedside Diagnosis" published in 1928. Very little is said in this article relative to the bacteriology of lung abscess, but the following observation is made: "Secondary to Rare Infections (Spirochaeta Bronchialis Castellani). The occurrence of abscess in these infections is rather rare. They resemble tuberculosis in their general symptomatology and course. Signs of cavitation may, as is this disease, occur, but the acute abscess is rather uncommon. We have seen an abscess second-

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ary to spirochaetal infection in a patient reported by Mason as an example of pleural spirochaetosis." This quotation shows how little importance Heuer, in 1928, gave to the spirochete in the formation of an acute abscess. Turn now to *Surgery, Gynecology and Obstetrics* for February, 1931. Here in an article entitled "The Etiology and Treatment of Pulmonary Abscess" by G. J. Heuer we find the following: "Culturally and by smears all recent studies have shown that the sputum in 70 per cent or 75 per cent of the cases contains predominantly the anaerobic organisms common to the mouth; in others, various pyogenic organisms." And again, "Clinically the multiplicity of lesions, including various forms of bronchitis, bronchopneumonia, abscess, gangrene and bronchiectasis, seen in spirochetal infections of the lung; the occurrence of two or more lesions in the same individual as abscess and gangrene, abscess and bronchiectasis, pneumonia and abscess, and so forth in other pulmonary infections; and the analogy of the various manifestations of the same infection in tissues other than the lung, all suggest the idea of one condition modified by various factors. Experimentally various lesions including pulmonary abscess, pulmonary gangrene, and bronchiectasis have been produced in rabbits by one investigator using exactly the same method and the same organisms (D. T. Smith)." This is certainly a reversal of opinion, by an authority, as to the organisms that are the causative agents in the formation of lung abscess, and that reversal is within the span of three years as testified to by the two publications.

This tardy recognition has apparently been due to the complicated bacteriological problems involved. The causative organisms have long been recognized as entities, but their common origin in the mouth led many observers to consider them merely a contamination when they were found in the sputum of a patient suffering from a respiratory infection. Then, too, the failure to cause the disease experimentally was a stumbling block to the general acceptance of the idea, until Smith[25] reported the experimental production of all forms of pulmonary infections by the intratracheal injection into mice and guinea pigs of washed sputum containing spirochetes, fusiform bacilli, vibrios and cocci, recovered from patients with pulmonary abscess and chronic bronchiectasis. His work proved the infection to be caused by a symbiosis between spirochetes and fusiform bacilli which could not be caused by either alone. Details of the bacteriology will not be taken up here, nor the technique of obtaining the proper specimens of sputum for examination. Suffice it to say that care must be taken to obtain sputum and pieces of débris brought up from the lung and as free as possible from mouth contamination. This is best examined by special stains, such as Fontana and Kliewe. There is no mention in recent literature dealing with human spirochetosis of the Kliewe stain. The ordinary laboratory stains do not show these organisms well, and Dr. Carlos Pons, our pathologist, in looking up various stains discovered on a personal visit to Johns Hopkins that this stain was being used by Dr. Harris[6] in research work in spirochetosis gallinarum. He has found this stain the most satisfactory one in the examination of human sputa, and no doubt the frequency with which we have been finding this infection lately is due, in no small part, to the improvement in our laboratory technique accomplished by the use of this stain. Excellent work has been done in the bacteriology of this infection by Bethune,[1] Smith,[24,25] and Kline and Berger.[12]

Since the recognition of this disease is largely bacteriological, the question may be asked why this subject should be of interest to the roentgenologist. Sufficient reason is contained in the fact that many of these cases will respond to intensive arsphenamine treatment, if commenced early, as pointed out by Kline and Berger,[12] Pilot and Davis,[18] and Graham.[5] The response is in direct proportion to the early

recognition of the disease. The more chronic lesions, especially the abscess formations with fibrous capsule, are stubborn. All those, therefore, who are concerned with the examination and diagnosis of chest diseases should be conversant with this form of respiratory infection, its incidence, its variety and other factors concerning the course, such as the likelihood of one manifestation changing to another, or two occurring at once, as has been mentioned above. We have found some form of spirochetal disease as common a respiratory infection as active tuberculosis in cases admitted to the open wards of our general hospital. This has been substantiated in a letter to one of my colleagues, Dr. Pons, from Dr. Wm. Belk of Philadelphia, who, becoming interested in Dr. Pons' bacteriological study of the cases reported in this paper, examined the sputa of 44 cases with respiratory lesions and reported finding spirochetes in 15 per cent. Many cases of acute abscess may be prevented from developing a chronic abscess, if recognized and treated early. Other cases may be saved from operation. Of course, it must go without argument that postural drainage, bronchoscopy, and in some cases, surgical interference, must all be considered in the treatment of each case.

One of us, as internist, and the other, as roentgenologist, have seen, examined and treated during the past two years some 39 cases of fusospirochetal pulmonary infections. Thirty-three of these cases are reported in this paper, 6 are not included either because they were not observed for a sufficient length of time, or could not be followed up, or the findings were not sufficiently conclusive to bear reporting, though we considered them positive. These cases may be summarized as follows:

A. Acute fusospirochetal bronchitis (2 cases)

B. Primary fusospirochetal bronchiectasis
   a. Acute (3 cases)
   b. Chronic (8 cases)

C. Fusospirochetal pneumonitis
   a. Simple, diffuse (2 cases)
   b. With bronchiectasis (2 cases)
   c. With cavity formation (3 cases)

D. Fusospirochetal pulmonary abscess
   a. After tonsillectomy (2 cases)
   b. After tooth extraction (3 cases)
   c. After pelvic operation (1 case)
   d. After antrum operation (1 case)
   e. After external trauma to chest (1 case)
   f. Spontaneous (4 cases)

E. Fusospirochetal pulmonary gangrene (1 case)

Of these, 17 were male, and 16 female, showing therefore no tendency toward one sex. They were divided according to age period as follows: Under twenty there were 4; between twenty and thirty, 10; between thirty and forty, 11; over forty and under seventy, there were 8; no cases were over sixty-six. The greatest incidence was therefore between the ages of twenty and forty. All of these cases were treated with arsphenamine; 16 were cured, 15 were improved and 2 unimproved. We adopted rather severe qualifications for marking a case cured. The patient had to be clinically free from symptoms, roentgenologically and bacteriologically negative in order to be so classified. The improved list carried all of these who showed improvement in any field, most of them being clinically nearly well but still showing roentgen or laboratory findings that were positive. The cured and improved were found according to the following table:

	Cured	Improved	Unimproved
Bronchitis	2		
Bronchiectasis	5	6	
Pneumonitis	6	1	
Abscess	2	8	2
Gangrene	1		

Of the unimproved, one died. The best results it will thus be seen were found in the cases of bronchitis and pneumonitis, while the poorest results were found in the abscess group. Many of these cases are still under treatment. The group as a whole presented the following symptoms as shown in the following table:

Cough	33	Pleural pain	21
Expectoration	33	Hemoptysis	14
Foul sputum	32	Night sweats	15
Fever	27	Chills	7
Loss of weight	27		

The following findings significant in spirochetal infection were found in the group:

Dental sepsis	22	Physical examination positive	31
Infected tonsils	6	Wassermann and Kahn positive	6
Spirochetes	33	Wassermann negative and Kahn positive	3
Fusiform bacilli	30		
Vibrios	18		

All of the cases had more or less intensive arsphenamine treatment. A specimen chart is shown to give an indication of the reaction to each injection and the definite improvement that took place in most cases as a direct result.

Roentgenographically, however, there are many interesting points to be brought out. In classifying pulmonary spirochetosis, we have adopted the following outline of the pathology involved:

Bronchitis—Ulceration limited to mucosa
1. Acute
2. Subacute
3. Chronic

Bronchiectasis—
Formation
1. Ulceration of bronchial wall
2. Elastic tissue destroyed
3. Blood vessels eroded
4. Dilatation of bronchus
5. Bronchiectatic abscess

Healing
1. Fibrosis
2. Stenosis with dilatation
3. Epithelization of dilated area

Pneumonitis—Parenchymal infiltration
1. Circumscribed
2. Diffuse
3. With or without cavity formation
4. Lobar or lobular

Abscess—Bronchopulmonary consolidation with central necrosis, single or multiple
1. Acute—collateral inflammation
2. Subacute
3. Chronic—collateral inflammation replaced by dense fibrous tissue

Gangrene—Destruction of pulmonary tissue extensive and rapidly progressive

This classification is satisfactory to the clinician since he is able to group appropriate symptoms and physical findings about each member of the classification, and it is satisfactory to the roentgenologist since the terminology fits the roentgen appearance. It is not quite satisfactory to such investigators as Kline and Berger[12] who insist that all cases of so-called lung abscess due to spirochetal infection are a form of lung gangrene. More will be said of this later.

In the acute bronchitis cases, the roentgen examination may be negative except for exaggerated pulmonic markings. They cannot be distinguished roentgenographically from any other form of bronchitis. When such cases come to the roentgenologist, however, with a rather copious expectoration, possibly blood-tinged and generally with a foul breath (we had, however, one case without a foul odor), the roentgenologist should consider that acute fusospirochetal bronchitis is probably present. A typical history of such a case follows:

Case 1. (Spirochetal bronchitis.) F.J., male, colored, laborer, aged twenty-eight.

History. Admitted to the hospital with a diagnosis of influenzal bronchopneumonia. Sudden onset with chill, general malaise and cough three days before admission. Cough soon became productive of a blood-tinged purulent sputum. No definite hemoptysis; no chest pain; no history of any operations or sore throats.

Physical Examination. An acutely ill man slightly irrational. Chest—coarse râles heard throughout the right chest anteriorly and posteriorly. Few medium and coarse râles over left base posteriorly. No signs of consolidation.

Sputum. Copious and foul. On admission was sanguino-purulent. Myriads of fusiform bacilli and spirochetes.

Wassermann and Kahn tests negative.

Roentgen Examination. Roentgenoscopically, apical aeration was only fair on either side, slightly better on the left. Expansion and aeration fairly good on both sides, aeration being much better in the lower half of both lung fields. Diaphragmatic excursion was normal on both sides. The costophrenic angles were clear. Heart and aorta appeared within normal limits as to size and shape.

Roentgenograms were taken in the postero-anterior position (Fig. 1). These did not show any definite pulmonic pathology in the upper half of each lung field where roentgenoscopically we noted decreased aeration. There was some accentuation of pulmonic markings of the bronchi of the second order, particularly in the upper right. We did not feel warranted in making a definite diagnosis of any particular pulmonic pathology. We did not see any consolidation such as bronchopneumonia as indicated on the request. We advised early re-examination.

FIG. 1. Case 1.

The patient made a complete recovery.

Chevalier Jackson[8] has reported finding definite ulceration in the bronchi in a case of spirochetal bronchitis.

In the cases of recent primary fuso-spirochetal bronchiectasis the plain roentgen examination may be negative unless the case is examined at a time when the dilated bronchi are filled with mucus, or unless there is an associated pulmonitis, or a true peribronchitis. This latter is very likely to be present since the spirochetes are the advance guard of the infection and burrow through the bronchial wall, with the pyogenic organisms invading the tissue behind them. The spirochetes are essentially anaerobic. Anatomically, the bronchus and the artery are not unlike (Smith), both being supplied with elastic and muscular tissue. The fusiform and bronchiectatic cavities may be compared to similar changes in the arterial walls in the case of aneurysm. The *Treponema pallidum* destroys elastic and muscular tissue in the artery in the same way that the spirochete does the same tissue in the bronchial wall. In cases with much the same roentgen appearance as in bronchitis but with a longer history, bronchiectasis should be suspected and in both types of case, if clinical condition permits, a lipiodol injection should be made to confirm or rule out bronchiectasis. We have found the supraglottic method of Pritchard to be quite satisfactory and to be superior to a bronchoscopic injection. In cases where the patient cannot very well cooperate, we have found that a direct painting of the rima glottidis with cocaine and the direct injection of butyn followed by the oil can be given without much difficulty. In cases with much mucus accumulation it is well to try by postural drainage to clear the bronchi as much as possible before injection, since otherwise one may fail to get the lipiodol below the bronchial bifurcation. The dilated bronchi and the bronchiectatic sacculations are of course seen after filling with lipiodol, either roentgenoscopically or roentgenographically. We believe it is advisable to make the roentgen examination as soon as possible after injection.

In cases of bronchiectasis where the history indicates that the condition has been present for some time, we may find typical cavitations showing, with a clear center and density about them due to fibrous tissue proliferation. This fibrosis is generally limited to the bronchi and connecting cavities. It may be difficult on plain roentgenograms to differentiate these from true lung abscesses or from tuberculous cavities. Pleural exudate accompanying the condition may entirely conceal evidence of the bronchiectases.

A typical case history of a primary bronchiectasis follows:

Case II. (Spirochetal bronchiectasis.) J.G., male, white, student, aged fifteen.

History. Admitted to the hospital with a diagnosis of chronic bronchitis, question of tuberculosis. Complaint dates back nine months. Since that time he has had attacks of pain in the chest, periodic attacks of coughing with mucopurulent sputum, which were followed by vomiting. Patient has night sweats, but no hemoptysis; no feeling of weakness; no loss of weight.

Physical Examination. Young white male, undernourished. Running slight fever. Fine râles in left apex with bronchovesicular breathing. In both bases moist coarse râles, inconstant, with coarse breathing, on right side close to the spine in mid-chest posteriorly. Physical examination otherwise negative.

Sputum. First examinations were negative; subsequent examinations showed fusiform bacilli and spirochetes.

Roentgen Examination. First examination without lipiodol showed soft, feathery peribronchial lesions in upper left and the lower right and upper right; near the hilus on the right side a large fibrous ring which we did not believe to be a cavity; it extended from the pleura posterior to the hilus; no fluid present in or near it. Diagnosis at the time was tuberculosis. The tubercle bacillus was never found. Lipiodol was subsequently injected and this examination showed bronchiectatic cavities (Fig. 2), and sputum was positive for spirochetes.

In pulmonitis we have a variety of lesions so far as location within the lung, size, and multiplicity are concerned. These areas may be circumscribed, diffuse, petechial or lobular. While they are more common in the right lower lobe, they may be seen anywhere. We may have a single area that closely resembles pneumococcic lobar pneumonia. We may have a type which is bilateral in both upper lobes, closely simulating bilateral pulmonary tuberculosis. A report is herewith given of a case that was seen by us and diagnosed as tuberculosis and sent to a sanitarium. The patient made a spontaneous recovery and two years later re-entered our hospital with a similar attack. At this time, being on the lookout for spirochetosis, we made a correct diagnosis.

Fig. 2. Case II.

Case III. (Spirochetal pulmonitis.) W.W., male, white, aged twenty-three; second admission.

History. Two years ago patient had night sweats, productive cough, loss of weight. He was admitted to the hospital and physical and roentgen examinations showed what we believed to be a bilateral pulmonary tuberculosis. He was sent from this hospital to a county tuberculosis sanitarium. In neither institution was a positive sputum obtained. He made what seemed to be a remarkable recovery for an extensive pulmonary tuberculosis. Subsequently he had attacks of coughing, fever and weakness, from each of which he recovered. He re-entered the hospital in June, 1931. At this time he had dyspnea, no hemoptysis, but afternoon fever, pain in the chest and productive cough.

Physical Examination. Increased lung resonance, breath sounds increased in upper left. Many dry and sibilant râles; few moist crepitant râles, right upper lobe. Teeth and gums in fair condition. Breath somewhat unpleasant but not foul.

Sputum. Mucopurulent, both at this time and on previous admission. At this time spiro-

FIG. 3. Case III. 1929, first admission.

chetes and fusiform bacilli were found. At previous admission they were not looked for.

Roentgen Examination. At the first examination in 1929 there was a diffuse bilateral pulmonitis, both upper lobes, especially marked in upper left (Fig. 3). Reported as a tuberculous pulmonitis. At the examination in 1931 (Fig. 4) some fibrosis was noted in both upper lobes, with accentuation of lung markings, more of this on the right than on the left, with slight retraction of the heart and mediastinum to the right. This was on the side which was less involved in 1929. Examination following lipiodol injection did not show bronchiectasis.

The discrete petechial type may roentgenographically resemble bronchopneumonia as well as tuberculosis. We have even seen those which roentgenographically made us think of a pulmonary malignant metastasis. It is in the pulmonitis type that the best therapeutic results are obtained, if we except the bronchitis cases, which, while common, are seldom recognized. Of course, the pulmonitis type may follow upon a bronchitis, and bronchiectasis, abscess and even gangrene may succeed the stage of pulmonitis. We wish to draw attention at this point to observations which Pilot, Davis and Shapiro[19] make in regard to the confusing of spirochetal pulmonitis with syphilis of the lung. It will be noted that in our cases 6 had positive Wassermann and Kahn reactions, and 3 others had a positive Kahn, although the Wassermann was negative. These cases all responded to arsphenamine treatment. We believe in the observations of Pilot, Davis and Shapiro in such cases, according to their statement: "A review of reports in the literature would indicate that syphilis of the lung is more common than has generally been believed. The basis of the diagnosis has been the presence of an infiltration of the lung in a patient with a positive Wassermann and the subsequent cleaning up of the lesion by specific therapy. The cases reported as syphilis often resemble our cases of fusospirochetal abscess. The sputum may be foul and the infiltration as in fusospirochetal abscess will resolve with arsenic therapy." We, too, believe that some of the cases reported in the literature as having shown luetic lung lesions which have been cured with arsenic-

FIG. 4. Case III. 1931, second admission.

als were probably fusospirochetal pulmonitis or abscess.

We have noted in many of these cases, and this is also true in the abscess group, that while the patients may clinically improve, roentgenographically the lesion spreads and may become diffuse, whereas before it was discrete. We have noted a number of cases with involvement of the upper lobe which during the course of treatment showed fine, discrete lesions or deposits appearing throughout the lower lobe on the same side and even in the clear lung on the opposite side. We have not determined as yet whether this is caused by new foci developing as a result of bronchial spill, or whether these small patches represent lymph blockage as in silicosis, or whether they are small areas of atelectasis. If these small areas represent new foci of infection, it would seem strange that they are found when the patient is apparently improving clinically. We have undertaken some animal experimentation and hope at a later date to be able to give some idea as to the nature of these areas.

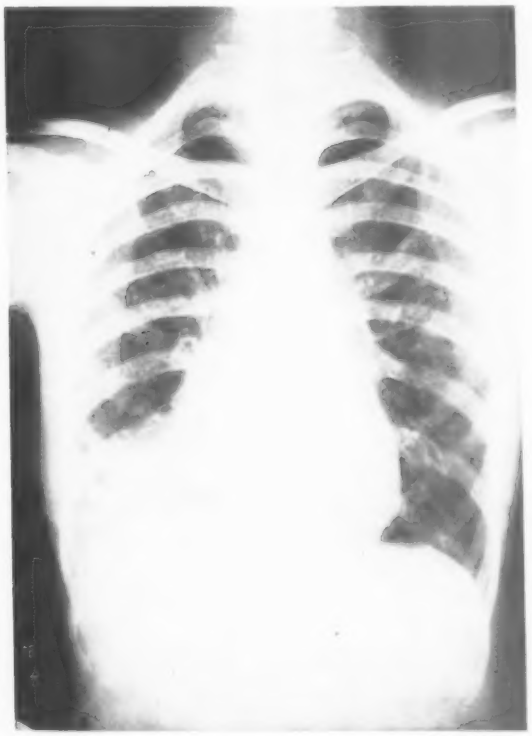

Fig. 5. Case iv. First examination.

Fig. 6. Case iv. Second examination; after lipiodol injection. Pulmonitis has cleared up.

Case iv. (Acute spirochetal pulmonitis.) Mrs. E. Van N., white, housewife, aged thirty-two.

History. Admitted to the hospital with the diagnosis of tuberculosis. For the past three weeks the patient has had a cough which after a few days became productive of a thick purulent sputum. One week before admission had brisk hemoptysis. Night sweats and pain in the right chest. No history of operation.

Physical Examination. An acutely ill woman. Mouth—dental sepsis. Infected tonsils. Chest—dullness and diminished breath sounds over the right base posteriorly. Many coarse râles over right upper lobe posteriorly and over left base.

Sputum. Copious, sanguino-purulent for a few days after admission. Amount, 4–8 ounces daily. Repeated examinations negative for tubercle bacilli but the specimens contained myriads of fusiform bacilli and spirochetes.

Wassermann and Kahn reactions four plus.

Roentgen examination on admission (Fig. 5) showed infiltration of the extreme right base.

A typical lung abscess presents no difficulty to the roentgenologist, so far as the gross pathology is concerned, when it has reached the stage of central necrosis with

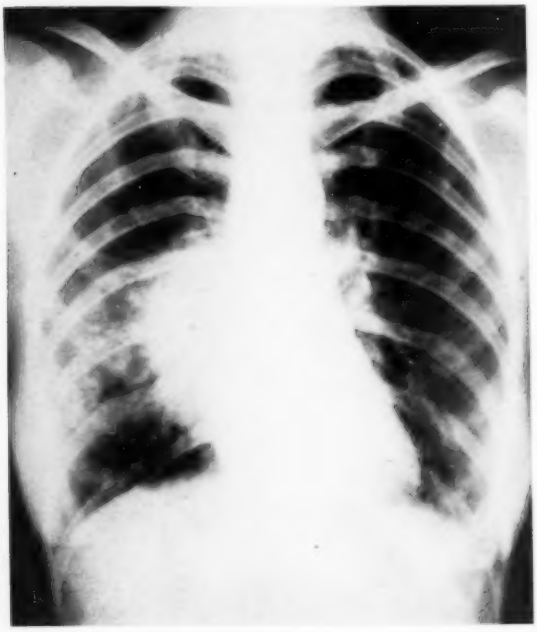

FIG. 7. Case v. First examination.

superimposed air bubble and surrounding collateral inflammatory process. It may present difficulties before the central necrosis is apparent and when it resembles consolidation or pulmonitis. The true cases of pulmonitis, which we intend to include in our classification, do not appear usually as consolidation within our meaning of the term on well-taken roentgenograms, since lung markings in the pulmonitis cases are always visible. When, therefore, the involvement appears as a solidification in the case that is known to be a Vincent's infection, we believe it represents abscess even though central necrosis is not apparent. It is this type of case that may be taken for pneumonic consolidation when the bacteriology of the process is unknown. Abscesses may be single or multiple, may have a diffuse area of involvement, or may be rather sharply circumscribed, as in the chronic case with collateral inflammation replaced by fibrous tissue. As we have stated above, Kline and Berger object to the use of the word "abscess" in describing lesions of spirochetal origin that have necrosis of tissue with foul expectoration. They believe that these cases should all be called lung gangrene, and that only abscess formations due to pyogenic organisms with a whitish-yellow mucopurulent or purulent sputum that has little appreciable odor should be called lung abscess. This type of lung abscess may be embolic or aspiratory. This type is much less frequent than the type with foul sputum with brownish or greenish expectoration, which has been shown to be due to spirochetal infection. We have adhered to the older terminology merely because it is in more common use and is more generally understood by all medical men, and it is more descriptive of the lesion seen roentgenographically. Lung gangrene we have reserved for that type of case described by Smith[22] as follows: "In the cases of pulmonary gangrene the tissues seem unable to set up an adequate defense against the gangrenous process, which spreads rapidly in every direction, destroying tissue as it goes." Of course, only rarely can the bacteriology of a lung abscess be guessed from its roentgen appearance, and we therefore prefer the term "lung abscess" for that form of spirochetal infection that has the appearance of an abscess, even though technically speaking from a pathological standpoint, it may be a localized gangrene. Lung abscesses, of whatever bacterial origin, may be mistaken roentgenographically on occasion for tuberculosis or encapsulated empyema. Only experience and the judicious use of various positions and angles of roentgenographing the patient, or roentgenoscoping him can help to determine which condition is present. It is important for the roentgenologist to remember the two distinct types of lung abscess from the bacteriological standpoint, because they are amenable to distinctly different types of therapy, and he must therefore be on the lookout for the development of lung abscess in fusospiro-

chetal infection and do his part to see that proper therapy is instituted, since cure is in direct proportion to the early recognition of the disease. When once the fibrous ring is formed in place of the collateral inflammation, the value of arsphenamine therapy diminishes considerably.

While practically all cases of fusospirochetal abscess are aspiratory, they may have exciting causes. They may develop spontaneously without any apparent preceding illness; 4 of our cases were of this spontaneous variety, or they may follow an influenzal attack, or may arise as a complication in pneumonia. We had one case arising as a result of bronchial blockage by bronchiogenic tumor. We had 2 cases following tonsillectomy, and 3 cases following tooth extraction; in none of these latter cases was there a foreign body present, but of course such cases do occur. We had one case following a pelvic operation, and one case after operation upon the antrum. One case was rather unusual in that the patient attributed the onset of his symptoms to an accident in which he received a bruising but non-penetrating wound to the chest. The following is a typical history of a postoperative pulmonary abscess; one of a spontaneous pulmonary abscess is also given:

Case v. (Postoperative spirochetal pulmonary abscess.) Mrs. A. E., white, housewife, aged twenty-six.

History. Two attacks of tonsillitis in the past four years, one attack of quinsy one year ago; frequent colds. Entered the hospital on April 20 for pelvic operation; operation on April 22; on April 23 complained of pain in the chest. Temperature 101°F.

Physical Examination. Definite evidence of pulmonitis, with flatness, bronchial breathing, râles and localized tenderness. No expectoration at this time but spasmodic coughs.

Roentgen Examination. Definite involvement of the right lower lobe, pulmonitis with possibility of abscess developing (Fig. 7). Roentgenograms taken subsequently showed definite abscess formation with a cavity (Fig. 8).

Subsequent History. Patient was discharged on April 30. At this time she had a foul sputum, which grew progressively larger in quantity. Spirochetes were definitely found. Patient quite anemic. While at home the patient received twelve arsphenamine injections. During the past month no fever; slowly getting well; spirochetes disappearing from sputum.

Fig. 8. Case v. After development of central necrosis and abscess cavity.

Case vi. (Spontaneous spirochetal lung abscess.) Mrs. A. W., colored, laundress, aged twenty-four.

History. Admitted to the hospital with diagnosis of pulmonary tuberculosis. Had felt poorly for several weeks. Cough with profuse expectoration for four weeks before admission. Indefinite pains in the right chest, chilly sensations, night sweats and marked loss of weight. Several attacks of tonsillitis. Pneumonia two years ago. No operations.

Physical Examination. Thin poorly nourished woman, acutely ill. Mouth—dental sepsis. Tonsils congested; considerable pus can be expressed. Chest—markedly emaciated; retraction over right infraclavicular region. Impaired resonance over right upper lobe. Amphoric breathing and many coarse and consonating râles heard over this area. Posteriorly over the right suprascapular region the same signs can

FIG. 9. Case VI. Initial examination.

be elicited. Temperature 101°F. on admission.

Sputum. Foul odor, quantity 10–15 ounces daily. Repeated examinations were negative for tubercle bacilli, but myriads of fusiform bacilli and spirochetes were found.

Wassermann and Kahn reactions four plus.

Roentgen Examination (Figs. 9 and 10). Roentgenoscopically there was practically no aeration in the upper half of the right lung and a definite fluid level could be made out about the level of the second rib anteriorly. Roentgenograms showed an area of induration apparently limited below by the interlobar septum between the upper and middle lobes, with a definite fluid level which was somewhat more posterior than anterior. Appearance was typical of a pulmonary abscess. Diaphragmatic excursion fairly good on both sides.

We have already stated our definition of a lung gangrene. Kline and Berger[12] state that while a number of cases of aspiratory abscess and gangrene follow operation under general anesthesia, the majority of the cases do not have any relation to operation. This was true of one case of lung gangrene which we present. This case illustrates a widespread, sweeping involvement of an entire lung. This patient entered the hospital with a diagnosis of acute rheumatic fever and did not develop any chest symptoms until after he had been in the hospital for over ten days. When first seen by us the right lung showed a diffuse infiltrative process which spread out from the hilus symmetrically into the entire right lung field, and this rapidly spread until the whole of the right lung was involved. This patient made a complete recovery and was discharged from the hospital about two months after entry, and when last heard from was working every day. His history follows:

CASE VII. (Fusospirochetal gangrene of the lung.) J. M., male, colored, laborer, aged twenty-nine.

History. Admitted to the hospital with a diagnosis of acute rheumatic fever (two weeks). Several sore throats.

Physical Examination. Acutely ill man with polyarthritis. Mouth—teeth and gums in fairly good condition. Throat—tonsils cryptic and infected. Chest—lungs negative.

Wassermann and Kahn reactions negative.

Course. After receiving salicylates for ten days joint symptoms markedly improved, but he developed cough and pain in right chest which increased on deep breathing. Diagnosis:

FIG. 10. Case VI. Abscess developed

pleurisy. Three days later a few fine and medium coarse râles noted in right axilla. Patient gradually became worse; cough and pain increased; definite dullness and bronchovesicular breathing in right side just below angle of scapula. Diagnosis: pneumonia. Cough became productive of thick purulent sputum which was definitely foul in odor and slightly blood-tinged. This was examined for tubercle bacilli, fusiform bacilli and spirochetes but none were found. The following day (nine days after onset of chest symptoms) patient had a hemoptysis of about 4 ounces of pure blood. Examination of sputum showed many spirochetes, fusiform bacilli, vibrios and elastic tissue. Diagnosis: pulmonary gangrene. Patient had repeated hemoptyses and coughed up from 16 to 20 ounces of sputum daily. This was undescribably fetid, and on standing it separated into the classical three layers.

We have attempted in this paper to give a brief summary of the researches and findings of other investigators in regard to this form of pulmonary infection, and to give such information in regard to the bacteriology, pathology, and roentgen appearance of the lesions as we believe every roentgenologist should be conversant with. We have presented some facts gleaned from the study of 33 cases and have presented typical case histories and illustrative roentgenograms. We trust that this series of cases will be of interest to those roentgenologists who are fully conversant with the lesions described, and we hope that it will stimulate interest in those who have not considered this a common pulmonary infection. We have not presented any new findings unless it may be the use of the Kliewe stain in the bacteriological examination. We believe this infection to be a fairly common one, and we believe that early diagnosis is important from the standpoint of specific therapy.

Fig. 12. Case vii. At time of discharge.

Fig. 11. Case vii. At height of disease.

We are indebted to Dr. Pons, our pathologist, for his interest and skillful work in making this report possible.

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DISCUSSION

DR. W. P. BELK, Bryn Mawr, Pa. Dr. Herrman's paper is an excellent one and gives a very thorough review of this subject. I can add nothing to it scientifically, but I wish very heartily to endorse all that he claims for this subject in his paper.

I realize that there is some skepticism as to whether the so-called Vincent's organisms are the primary etiological agent of these various pulmonary lesions, or only secondary invaders. Experimental work, especially that of Smith, who produced characteristic lesions in animals with pure cultures of these organisms in symbiosis, seems to me rather convincing. Moreover, Smith was unable to demonstrate these organisms as secondary invaders in 150 known cases of pulmonary tuberculosis. In addition, the excellent results obtained in many cases with neoarsphenamine, a spirocheticide, adds considerable weight to the argument for the primacy of these organisms.

I believe, however, that the real reason for this skepticism lies in the fact that "Vincent's" organisms are so infrequently demonstrated in sputum. This in turn is due, I am sure, to failure on the part of pathologists to observe several simple but essential details in technique. I was myself guilty of this failure for a number of years, but during this present year I have discovered 9 typical cases by practising the method used by Dr. Pons, who did the pathological work for Drs. Herrman and Altschul. The essentials to be observed are (1) a fresh specimen of sputum, not over thirty minutes old, collected after thoroughly cleansing the patient's mouth, (2) the selection of sandlike granules from the specimen, although purulent or liquid portions may less frequently contain spirochetes, (3) the use of Sterling's gentian violet, Kliewe's, or Fontana's stain, (4) the examination of several specimens before making a final negative report.

In the present year, I have detected 9 very typical cases in 50 examined. This makes a positive finding of 18 per cent. It was interesting to me in reviewing reports of sputa examined for tubercle bacilli that I found these bacilli in only 12 per cent. In other words, after a brief experience, fusospirochetal disease seems to be more common possibly than pulmonary tuberculosis in routine work in our hospital.

There is, I believe, nothing diagnostic about the roentgen appearance of these cases. Certainly the pathological anatomy is not different from that of other acute or chronic suppurative processes. The entire interest is in the demonstration of a special etiologic agent.

I believe that this group of roentgenologists

could do much to clear up the doubts concerning fusospirochetal disease of the lungs by taking the initiative in the several groups of physicians with whom you work in giving this matter a thorough trial.

I would like to show you three or four slides similar to those Dr. Herrman showed you.

(Slide) This is a case of typical lung abscess. It is of interest that a specimen obtained at bronchoscopic examination for Dr. Tucker showed no spirochetes, although subsequent examinations were characteristically loaded with them.

(Slide) This is an early case, only one week's duration, of pneumonic type.

(Slide) There is a chronic case, an ambulatory patient who has had trouble for about one year and is still coming to our dispensary irregularly. He was treated for a while but he is not very cooperative. He never really gave us an opportunity to benefit him. I believe the acute process from which he suffers can very probably be cured by intensive treatment with arsphenamine.

(Slide) This is another type of case very similar but who came into the hospital with an acute exacerbation and died. It was the first case we discovered, and although the patient had been in the hospital several weeks, we only made the diagnosis the day before he died and he was not treated. I think we might have saved that patient's life had we had our present knowledge.

Dr. E. P. Pendergrass, Philadelphia. The lack of attention of roentgenologists to this form of pulmonary pathology has been largely due to the absence of a consensus of opinion among bacteriologists that the fusiform bacillus and the spirochete are the causative agents in fusospirillary pulmonary conditions. The evidence is not conclusive as yet, but I do feel that in the light of this and other work, roentgenologists should consider an attempt to diagnose or exclude fusospirillary disease in cases presenting pulmonary pathology.

Smith and others have produced in experimental animals abscess, gangrene, bronchiectasis, etc., with anaerobic organisms removed from patients. These observations have tended to support the contention of clinical observers who have felt that the spirochetes and fusiform bacilli have been the causative agents of pulmonary disease.

The authors' thought in bringing this interesting subject before us was that the condition may be recognized early when there is a possibility of curing the disease by intensive arsphenamine therapy. They, and others, have observed that when the condition becomes chronic, it does not respond very readily to treatment because the damage has been done. The authors report 33 cases, and of these 33 they describe 7 in detail.

Their roentgen observations have been divided into the five groups, and some of these subdivided:

1. Acute fusospirochetal bronchitis.
2. Primary fusospirochetal bronchiectasis.
3. Fusospirochetal pneumonitis.
4. Fusospirochetal pulmonary abscess.
5. Fusospirochetal pulmonary gangrene.

This paper does not entirely prove the causative relationship between organisms of the Vincent type and bronchitis, bronchiectasis, gangrene, abscess, etc. It is, however, very suggestive, and especially if it is found by other observers to occur in as large a percentage of cases as found by these authors.

Bucher of Jefferson Medical College found these organisms in 25 per cent of exudates collected by the bronchoscope from bronchiectasis, abscess, etc. He believes that they are saprophytic, and produce no physical injury except that due to their physical presence, that they are inspissated from the mouth, and have no etiologic relationship with pulmonary infection. Dr. Belk believes the opposite. This difference of opinion can stimulate all of us to make a definite effort to evaluate the bacteriological findings in the future.

I question the advisability of making so many subdivisions of the roentgen findings. It is extremely difficult for one to make a roentgen diagnosis of bronchitis and early bronchiectasis. We repeatedly have the experience of making a negative diagnosis and finding that Dr. Tucker, who bronchoscopes the case subsequently, has made a diagnosis of tracheobronchitis or early bronchiectasis. We have been forced to the opinion that the diagnosis of bronchitis and early bronchiectasis is unreliable in the roentgen examination of the lung.

Dr. Gabriel Tucker, Philadelphia. There is something that as bronchoscopists we may be able to contribute, both in diagnosis and treatment, in spirochetal infection of the lung. I have talked to a number of bacteriologists relative to the examination of the secretion for spirochetes. As Dr. Belk says, a great many of

them do not pay much attention to it. The reason for that was explained to me this way: They take it for granted the spirochetes are in the mouth, large quantities and many varieties. When they find them in the sputum, it does not mean anything with ordinary methods of collecting specimens of sputum.

There is a method by which you can secure secretion from the lung that will not be contaminated by mouth secretion. Washing the mouth before collection of a specimen is more or less effective, but we can put a bronchoscope down into the lung and a specimen of secretion can be collected from the lung without contamination. We are certain of that.

I am glad Dr. Belk reported the specimen of secretion that I collected did not have spirochetes in it. It proved at least that that case was not contaminated by mouth secretions.

The spirochetal infection is not different, as far as bronchoscopic treatment is concerned, from other infections of the lung. One of the cases shown by the essayist, I believe would have been benefited by bronchoscopy. A very definite lesion of the right lower lobe was shown in which bronchoscopic aspiration would have been of benefit. Where there is evidence of obstruction and atelectasis and drowned lung, there is a clear indication for bronchoscopic drainage.

DR. HERRMAN (closing). In regard to lung abscess, I did not have time to bring out the following fact: Kline and Berger believe that there are two distinct types of lung abscess. One is the so-called pyogenic type, which may be single or multiple, and in the discharge from which only pyogenic organisms may be found. In the other type, the characteristic symbiosis of pyogenic organisms, fusiform bacilli and spirochetes is present. They emphasize the fact that it is most important to determine which type of abscess is present, since the treatment is fundamentally different. We had one patient who was treated in one of the leading clinics by bronchoscopy and postural drainage over some length of time, without any particular benefit, although there was copious drainage. Spirochetal infection had not been looked for, and no treatment based upon this finding was instituted. When he came under our inspection, we found a definite fusospirochetal infection and he received arsphenamine therapy. For a time he made definite improvement, but he was too much debilitated and did not have sufficient reserve, and he ultimately died.

Kline and Berger point out that the type of abscess caused by fusospirochetal infection is by far the larger group. It can be told clinically, because in many respects it resembles lung gangrene. In fact, they prefer to call this type of abscess localized gangrene. From this type of abscess you have the characteristic greenish-brown sputum. It is usually quite foul. The other type has the mucopurulent expectoration, which is not foul.

Dr. Heuer, writing in Blumer's Bedside Diagnosis, published in 1928, states that lung abscess following fusospirochetal infection is quite rare. With that remark, he practically dismisses the subject of fusospirochetal abscess, and merely mentions this type of infection under his discussion of bronchitis. The same author, in *Surgery, Gynecology and Obstetrics*, in February, 1931, makes the statement that probably 75 per cent of lung abscesses are due to the fusospirochetal type of infection, and that, of course, all lung gangrene is due to it.

(Slide) This slide is shown to indicate that whereas fusospirochetal infection roentgenographically may be mistaken for tuberculosis, the reverse is also true. After we had become quite interested in looking for fusospirochetal infection, this case came along, and while roentgenographically it looked very much like pulmonary tuberculosis, we made the observation that, until the bacteriologist reported on the sputum findings, we would not state definitely that this was tuberculosis.

(Slide—same case) Spirochetes were found in abundance in this case and no tubercle bacilli. He was treated on the basis of a fusospirochetal infection, and for a time he improved, but not for long. Autopsy showed that he had a generalized tuberculosis. In this case, the fusospirochetal infection was merely a secondary infection. In such cases, response to treatment, of course, is much diminished.

We have other cases which I do not have time to show you; for instance, one case where we had a lung tumor with a secondary fusospirochetal abscess. In another case, a lung abscess developed following the extraction of a tooth. This patient was treated on the basis of a fusospirochetal infection. No foreign body was found, but subsequently a tumor partially blocking the bronchus with the abscess development was found. It was probably purely coincidence that the lung abscess developed as the result of the bronchial blocking a few days after the extraction of this tooth.

VOL. XXIX, NO. 2

RADICAL TREATMENT OF CARCINOMA OF THE LIP*

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WE HAVE not found it possible to group all patients with carcinoma of the lip together and formulate one plan of treatment for them. The wide range of variation of the lesions has prompted us to divide the patients roughly into four clinical stages: First, early lesions of uncertain character that might be malignant. Second, small but active lesions in which there is little doubt as to the diagnosis (Figs. 1 and 2). Third, advanced lesions of indeterminate extent (Fig. 3). Fourth, the practically inoperable lesions. Another fairly definite group that has to be reckoned with is made up of patients who have had excessive or unknown amounts of radiation but who still have carcinoma (Fig. 4). These stages more or less govern the plans of treatment.

In practically all cases we undertake to obtain the lesion or part of it for micro-

A B

FIG. 1. A. This is a fairly local lesion, but one which had persisted for several months. Caustics and the "electric needle" had been applied. B. Treatment here was excision of the central one-half of the lip, and the repair was done immediately with a rectangular flap from the tissue remaining on the left side, and this defect was filled with a triangular flap from the upper lip. This double flap allowed complete restoration in one operation rather than swinging a flap directly down from above which would necessitate later severance and adjustment of the pedicle. Patient refused to have neck dissection done.

A B C

FIG. 2. A. This is a moderately large lesion that had persisted under caustics, radium and roentgen treatment. New activity had been evident for some time when first seen in this clinic. B and C. A radical removal was done, but the patient steadfastly refused a neck dissection. He was finally classed as a five-year "cure" but returned after eight years with a fatal recurrence that had been allowed to progress for one year. The main area of involvement here centers around the buccal gland and has invaded the jaw through almost the entire side. There is no suggestion of local recurrence.

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scopic examination. If the lesion is small, its total removal involves little more than obtaining a section for biopsy and therefore irradiation is seldom used in these cases.

A B C

FIG. 3. A. Shows an active lesion that has had no treatment other than the usual "caustics." B and C. About one-half of the lower lip was removed and a large flap swung into place immediately from the upper lip. Microscopic examination showed squamous cell carcinoma of fair cell differentiation (Grade 2). A bilateral upper neck dissection was done later. Patient well five and one-half years.

First Stage. In the early, indeterminate growths such as warts, thickened patches and fissures that recur and break down, if the best lip repair is desired, the lesion is excised through an oval opening, and careful suture is done. In the early typical lesions the cutting cautery is usually used, and spontaneous healing awaited. By these procedures (1) one is able to obtain good gross evidence of the extent of the lesion and accurate depth can be obtained even down in the muscle; (2) the trouble is eliminated most quickly; (3) the patient can return home without hospitalization; (4) the lesion can be studied microscopically; (5) the natural repair is so good that only the fastidious will want anything done (occasionally where there has been deep cauterization, it may be advisable later to excise the deep scar because of discomfort); (6) the question of dissection or irradiation of the glands will depend largely on the microscopic picture.

A B C

FIG. 4. A. Shows a lesion of almost a year's duration that had had much treatment including several radium applications. The buccal fornix was almost filled with growth that was definitely attached to the jaw bone. No glands could be felt in the neck, but there was heavy fat present that made palpation difficult. Treatment was widespread cautery removal and thorough cauterization of the bone. Spontaneous healing and separation of the sequestrum were awaited. B. Three months after operation there is complete healing with no sign of local recurrence The end of the upper lip has been pulled clear down and attached in the lower buccal fornix. C. Two weeks after repair with a flap from the upper lip.

Second Stage. (Figs. 1 and 2.) In definite

clinical carcinoma of moderate advancement, the tumor is removed and the repair made either by flaps from the same or opposite lip. This is very useful where unknown amounts of radiation have already been given. Dissection of the glands may be done at this time, but it is usually done later. In primary cases of this stage, radium may be used by choice.

FIG. 5. A and C. Show complete loss of lip following a paste treatment for what was said to have been a carcinoma. B and D. Show complete restoration of lip and chin and part of cheeks with a double pedicle flap from the scalp.

Third Stage. (Figs. 3 and 4.) In advanced cases whose character and history of treatment is such that no accurate determination can be made of the extent of the growth, wide removal or destruction is necessary. The defect may be repaired immediately but frequently a period of observation for recurrence is advisable before making a secondary repair. The cutting cautery is used in widespread removals.

Bone involvement should be looked for

carefully in all advanced cases (Fig. 4). The growth may invade the bone, but it more frequently becomes attached to the periosteum and buccal plate. Any bone involvement is destroyed with the cautery or the soldering iron, and spontaneous separation of the sequestra awaited before the repair is done. This time is not lost, because opportunity is given for observance of local recurrence and for contraction of the soft tissue defect.

Gland dissections in these advanced cases are frequently done at the primary operation, but may be delayed until it is fairly evident that there is to be no further local recurrence.

In order to support this plan of treatment, one must be able to make acceptable repairs in all operable cases (Figs. 1, 3, 4 and 5).

Fourth Stage. Inoperable cases are treated with radon, radium element, or roentgen rays.

Gland Involvement. It is our belief that no type of treatment of squamous epithelioma of the lip can be considered radical in which there is not a complete block removal of the related lymphatic areas in the submental and submaxillary regions as well as those in the side of the neck to at least well below the bifurcation of the carotid.

Palpability of lymph nodes does not necessarily contraindicate excision. A limited skin attachment can be excised with the gland mass, but attachments to the carotid artery are resected and treated by radium implantation. A really radical dissection for impalpable or non-adherent lymph nodes is relatively seldom followed by local recurrence.

Dutton pointed out that the lymph nodes may lie dormant and break out with cancer eight years after cure of the primary lesion. A patient on this service had a radical operation on the lip, but refused a neck dissection. He was later counted as a five-year cure, but returned after eight years with a fatal recurrence in the neck (Fig. 2).

Recurrence in glands may be so remote from the original lesion in time and in location that the patient may actually not remember that he ever had the original le-

A B C

FIG. 6. A. Involvement widespread throughout glands shortly following the destruction of a growth by a cancer paste. B and C. This patient had a cancer of the lip treated with radium (elsewhere) and a good local "cure" was obtained, but a neck dissection was not done. He was seen in this clinic one year later with a large metastasis in the buccal glands with wide involvement of the skin. A widespread dissection was done but the patient returned one year later with this second recurrence present in the parotid region. There is no sign of local recurrence and this is taken as an example of the early widespread dissemination of carcinoma and of the lessened efficacy of secondary dissections in comparison with primary ones.

sion. This may be mainly due to the original treatment having been given with no mention made of possible gland metastases. In most cases of supposed primary carcinoma deep in the neck, the origin could probably be traced back to some lesion on the lip or elsewhere in the mucosa.

The majority of lymph nodes we remove are negative for carcinoma, and yet, in watching these patients and having to bear the burden of carrying our uncured ones through the later stages, we have become convinced that many of those individuals who did not show the lesion in the nodes would probably show it at a later period. With or without justification, our practice is not to examine a neck in carcinoma of the lip with the idea of excluding the neck dissection, because, if the patient is physically fit for the operation, we do a radical neck dissection in practically every proved squamous cell carcinoma of the lip. This is based principally on the number of persons who come in with cured lip lesions but with inoperable neck lesions.

The sites of gland involvement are usually (1) submaxillary, (2) buccal, (3) around the parotid and (4) submental. The frequent statement that the submental nodes are the areas of main involvement and that their removal will suffice does not seem to be substantiated (Figs. 2 and 6).

The buccal gland apparently has a curious faculty of eating through the jaw bone, whereas the primary growth usually becomes only attached to the jaw bone. If the buccal patch is attached to the jaw bone and it seems possible to remove the surrounding lymphatics, neck dissection is done and the soldering iron used on the bone (Fig. 2). This rather widespread involvement makes it advisable in original neck dissections to elevate only a thin skin flap above and remove the platysma, the buccal glands and the lower pole of the parotid. It is practically impossible to save the inframandibular branch of the seventh nerve.

The degree of malignancy of the glands is close to the degree of malignancy of the original growth. With a lapse of time, the grade probably increases in the original lesion, and therefore late metastases may be of high grade malignancy. Early low grade local lesions that do metastasize usually show the same grade in the glands.

The salivary glands themselves are very rarely involved.

The death rate for neck dissections alone is very low. Outside of the 100 per cent death rate, the misery and economic waste of a patient living through the terminal stages of uncured cancer probably warrants going to any extreme that is approved to increase the chances of cure.

Roentgen therapy is given routinely on the neck whether a dissection is done or not. It is not used locally except in some inoperable cases. Some of the worst glandular involvements we have seen have occurred in patients who have been treated locally with roentgen radiation (elsewhere), but who have not even had the suggestion made to them that there might be some recurrence in the neck and to be on the lookout for it.

The upper lip requires as careful consideration as the lower. Growths here are notoriously thought to be usually of a basal cell type and generally less dangerous, but it is also well known that mixed types of growth may occur and metastases develop. Montgomery showed that 15 to 20 per cent of growths diagnosed clinically as basal cell growths will prove to be of the transitional type. The true basal cell types in this region may themselves be difficult of treatment, especially if they become active high up around the ala.

Prognosis. (1) Any person who has had carcinoma of the lip may have a gland recurrence at any time (up to eight years in this clinic) regardless of the brilliance of the local cure.

(2) There is absolute necessity of frequent careful examination of the neck for lumps if a dissection has not been done originally.*

* For discussion see page 248.

CARE OF CERVICAL GLANDS IN INTRAORAL CARCINOMA*

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INTRAORAL cancer, due to the many varieties, its resistance to treatment, and the many forms of therapy, attracts wide interest, and the literature on the primary lesions is abundant, including results. This is not true of metastases and we must remember that the great majority of these cases that fail to recover, fail due to metastasis in the regional glands—many even after the primary lesion has been successfully eradicated. It therefore behooves us to give careful consideration to the lymphatics from the onset. Many authors, including Ewing,[4] have called our attention to the fact that embolic cancer cells may be found dead in normal tissue at autopsy and in operative specimens. Meland,[9] Quick,[11] and others, speak of the cervical lymph glands as sieves that arrest the embolic cancer cells from mouth malignancies. Someone has very wisely made the statement that the best time to cure cancer is before it begins. Donaldson of London says that to control cancer we must destroy the lymphatic drainage bed. He has gone so far as to open the abdomen and place six chains of radium tubes subperitoneally in an effort to obliterate the lymph glands, thus hoping to arrest lymphatic spread from cancer of the cervix. This may or may not be a justifiable procedure but it serves to illustrate how pioneers are attempting another step in cancer control.

Tomanek[13] of Prague voices our opinion statistically by showing that if the regional glands are removed the natural barrier is taken away, thereby allowing the metastases to go into other parts of the body.

We have long felt that irradiating the regional lymphatics before the primary lesion is treated vigorously raises their power of defense against cells that may spread to them. This may be difficult to prove but we would hesitate to lay down any part of our armamentarium in our struggle against so valiant a warrior as cancer. Murphy, Maisin and Sturm[10] report on grafting tumors intradermally into both groins of rats, one groin having been exposed to one erythema dose of roentgen rays one week previously. The rate of successful growth on the untreated side was 83.6 per cent contrasted with only 28.6 per cent on the irradiated side.

Cade[3] comments that the "policy of omitting neck irradiation when nothing was felt proved disastrous." Juul[7] has shown that newly transplanted tumors are more vulnerable than growing ones. This may explain improved statistics from routine small external irradiation dosage to cervical glands.

As far back as 1922, Holdfelder,[6] Ewing,[5] and others, described a carcinoma dose of radiation. More recently in the review of Quick's cured intraoral cases, Martin and Quimby[8] found ten skin erythema doses to be the minimum irradiation from which uniform regression could be expected. Improved results seem to have followed greater dosage. There is not available sufficient statistics upon which to compare results from surgery with irradiation. With surgery alone Bloodgood[2] reports 50 per cent five-year cures of cervical nodes metastatic from cancer of the lip, and estimates 10 per cent in tongue metastases. Schreiner and Simpson[12] reported no cures of cervical metastasis with external irradiation and only 2 per cent five-year healing with unfiltered radium implants. They comment that after having used gold tubes for three years they anticipate a brighter future. The comparison of these two results, though not

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adequate from which to draw conclusions, yet serve to introduce the combined therapy used at Stockholm, Sweden,[1] Memorial Hospital, New York, and Steiner Clinic. For simplicity of description cases may be considered either as prophylactic, operable (surgico-radiological) or inoperable (radiological).

Prophylactic cases present no evidence of glandular invasion. These cases receive a full skin erythema dose of high voltage roentgen therapy to each side of the neck, the primary lesion being included. Later the primary lesion is treated. Six weeks after the first treatment the neck treatment is repeated. Should a slightly suspicious gland be encountered gold tubes sufficient to give ten skin erythema doses are introduced either through the skin or by exposing the node. If they are inserted through the skin a finger must be placed in the mouth to facilitate accurate implantation. If the gland is more than suspicious the case belongs to the next group.

The surgico-radiological group is progressively becoming smaller as only the enlarged, firm glands which have not broken down and become firmly adherent are now included. These cases are treated first by external irradiation as the prophylactic cases. Attempt is made to judge each case on its merits. Special regard must be given to the (1) condition of the host, (2) tumor cell type, (3) location of primary growth, (4) location and number of nodes and (5) condition of the primary growth. The operative dissection must be as radical as necessary to eradicate the disease and conservative enough to be compatible with continued life of the host. We do not close the wound until after small filtered radium emanation tubes are carefully placed in all suspicious areas. Following this the skin will usually not tolerate external irradiation but the case must be frequently examined for recurrence.

The radiological group includes cases with nodes either (1) fixed, (2) from embryonal carcinoma, (3) bilateral, (4) in debilitated hosts, (5) where the primary is not controlled or (6) recurrent. Here we do not feel that surgery offers a percentage cure which will justify the inconvenience caused the patient. External irradiation reinforced by interstitial implants offers palliation for a prolonged period, and a reasonable hope for an occasional cure.

A review is included of 257 cases of intraoral cancer treated from 1924 to 1930 at the Steiner Clinic; excluding the lip cases 41.3 per cent had nodes on admission. It can be seen from these figures that we were not fortunate in receiving many early cases. Of the 189 cases treated prophylactically 31, or 16.4 per cent, developed nodes. Of the cases treated surgico-radiologically we have 70 per cent of the lip metastases controlled. The combined results of the other

RESULTS OF TREATMENT OF CERVICAL METASTASES FROM INTRAORAL CARCINOMA—STEINER CLINIC

	Lip	Mucosa of Cheek	Tongue	Tonsil	Alveolus	Floor of Mouth	Total
Number of cases	88	39	45	15	21	18	257
Nodes on admission	11	20	20	10	3	4	68
Developed nodes	3	4	9	4	6	5	31
Operations	10	9	13	3	3	5	43
Cervical nodes controlled	7	1	1	1	0	1	11
Percentage controlled	70.0	11.0	7.7	35.0	0	20.0	

cases give only 11.3 per cent controlled. While these figures are very poor they are better than those formerly reported. This advantage I attribute to the addition of irradiation, and the fact that not all cases have gone over five years.

A great number of these patients were considered beyond the help of surgery and these were treated exclusively by irradiation. Of these, many were palliated but none controlled.

CONCLUSIONS

1. Metastasis from intraoral carcinoma is usually to the neck and proves fatal.

2. There is no completely satisfactory therapy; therefore all worthwhile agencies not incompatible with the life of the host must be employed.

3. Surgery alone will give some five-year cures.

4. Irradiation (including interstitial) alone will give a few five-year cures.

5. The correct combination of these two should give better results than either alone.

6. All workers should report their method of treatment and results so that the patient may have the benefit of the best therapy.*

* For discussion see page 248.

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SURGICAL TREATMENT OF METASTASES TO CERVICAL LYMPH NODES FROM INTRAORAL CANCER*

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THERE are so many factors involved in properly evaluating therapeutic measures in the treatment of any disease that it is not to be wondered that therapy for metastatic cancer of the lymph glands of the neck is a subject of controversy. All therapy which is not purely empirical has demonstrable value through experimentation upon animals, and the results of these experiments can be testified to both in the treatment of man and through comparative statistical study. The experimental method is the more scientific in that experiments on animals can be repeated and carefully checked in more than one laboratory. Statistical study, on the other hand, when it is based purely upon experience with the conditions and treatment of disease in man can never be exactly duplicated for checking over by another worker and therefore deductions based upon statistical study alone must be very cautiously accepted. In the study of the value of any therapeutic measure to be used in the treatment of cancer the foregoing broad statements are particularly pertinent.

Until we have an accepted constitutional remedy for the treatment of cancer, any therapy directed at the treatment of metastatic lymph nodes must aim at local obliteration of the foci of the disease. Such therapy now available is limited to operative surgical removal, to irradiation from a point outside the involved tissue or to so-called "interstitial irradiation" by means of radium element or radium emanations placed within the tissues.

Let us first consider external irradiation. The practical value of this type of irradiation is governed by the radiosensitivity of the cancer cell as compared to the normal tissue cells which surround it or which must be traversed before the radiation can reach the affected cell. It is a well-known fact that squamous cell carcinoma of the mouth, when it forms metastases to the glands of the neck, is very radioresistant; in other words, its radiosensitivity as a rule is practically the same as that of normal tissue. Therefore, very little curative value should be expected from external irradiation as a result of the direct destruction to cancer tissue by such irradiation. But there is another effect of radiation which is claimed to be of value; it is that radiation of proper intensity produces a fibrosis of malignant and normal tissue and in the case of metastatic carcinoma of the lymph glands of the neck not only does this fibrosis surround the lymphoid tissue directly affected but also seals the lymph channels and thus prevents further dissemination. There can be no question that radiation in certain quantities will produce fibrosis or even dense scar tissue, but there is very serious reason to believe that even the densest scar tissue offers no serious obstacle to the spread of cancer. Certainly in my own practice I have observed cancer spread across a line of scar tissue into a flap used for plastic repair of a defect and, in the case of metastases, even heavily fibrosed tissues of the neck appeared to me to offer no more resistance than normal tissue. In reply to the statement that through fibrous thickening of the capsule of the individual lymph nodes carcinoma may be imprisoned indefinitely, I have known a metastasis from breast carcinoma to be latent twenty-two years before it became apparent, and this without any treatment subsequent to radical surgical removal of the primary focus. I have also removed lymph nodes from the neck supposed to have been encapsulated by fibrous thickening of the lymph gland capsule and found

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on microscopic examination that the cells therein contained showed just as many mitoses and as typical staining qualities as other untreated metastatic lymph nodes.

Interstitial irradiation affords a more direct attack on the involved glands and theoretically should enable a more intensive "dose" to be delivered to the metastatic gland than to normal tissue which surrounds it. If we admit that metastases to the lymph nodes of the neck from intraoral carcinoma have approximately the same resistance to radiation as normal tissues, in order to destroy all cancer cells the introduction of the proper amount of radium or radium emanation must be done with sufficient accuracy to limit at least the major portion of its effect to the lymphatic tissue involved. A brief consideration of the anatomy of the neck will show how manifestly impossible this is to do unless the important structures are first exposed by incision and dissection. It is true that metastases from cancer of the buccal cavity are more or less constantly confined (at least in the beginning) to certain groups of cervical lymph nodes, but variations from the "usual" are so frequent, and the gland areas merge so imperceptibly one into the other, that successful treatment by interstitial irradiation must be regarded as accidental.

What about surgical removal? What does surgery offer more than irradiation? Let me hasten to admit that even the most radical surgery cannot remove all the lymph-bearing tissue which *might* be involved in metastases from intraoral carcinoma. But the paths of usual spread from various regions within the mouth are well known and these paths can be so thoroughly excised that recurrence in the operative field should be very rare indeed. In fact, it is theoretically possible to clear the neck of lymph glands and lymph vessels in both the anterior and posterior triangles on each side without materially interfering with the subsequent happiness or usefulness of the patient. Intraoral cancer rarely involves the lymphatics except in the two main triangles and the only rational objection to the radical operation necessary to clear these triangles is that it may be unnecessary or that it is useless.

It must be admitted that *radical* surgery for intraoral cancer metastatic to cancer of the cervical lymph nodes offers most to the patient provided the operation be undertaken before there is demonstrable cancer in the lymph nodes. By demonstrable cancer I mean cancer which is shown to be present in the lymph nodes through the routine microscopic examination of the excised nodes. This rule applies to all radical operations for cancer and should not be used against this operative measure any more than it should be used against the meticulous clearing out of the axilla in every case of operable cancer of the breast —and certainly results in the radical surgery of cancer of the breast are 100 per cent better in those cases in which cancer cannot be demonstrated in the excised axillary nodes than in those cases which show metastases present at time of operation.

In our series of 190 cases at Barnard Free Skin and Cancer Hospital the difference in percentage of five-year cures between the two groups with demonstrable and non-demonstrable glands is most striking—81 per cent five-year cures in the non-demonstrable as against 35 per cent in the demonstrable. With the lip cases excluded, our series shows 63 per cent five-year cures where glands showed simple hyperplasia as against 25 per cent with metastases to the excised nodes. These figures are based upon a total of 62 intraoral and 66 lip cases in which records are complete. In the group of private cases the difference is even more striking—100 per cent (only 5 cases) as against 37 per cent (16 cases). But what is of even greater significance than these figures is the fact that only 9 cases in both groups combined later returned with recurrence in the area from which lymph glands were removed and these also showed local recurrence. In these combined series which comprise 149 cases, 52 per cent showed on microscopic examination no evidence of

carcinoma in the lymph glands.* This does not truly represent the number in which metastasis would not have occurred because we know that in many cases metastasis may occur at any interval from the time of destruction of the primary growth. There are some cases, however, which apparently never form metastases. In the case of intraoral cancer, these cases will be few because, at least in our community, we see very few "early" cases. But if we subject every case to radical neck dissection we must necessarily perform a certain number of unnecessary operations. The trouble is that we have no way to predetermine which is useless and which is unnecessary; therefore, unless we wish to court disaster we must subject all patients to the same procedure. I have already stated that the operation is not followed by serious impairment of function. What about mortality? In our Barnard Hospital group, including radical operations on lymph glands for metastases from cancer of the lower lip, 39 of 190 patients died in the hospital following operation. This is rather an appalling number (21 per cent). But on an analysis of these deaths we find that 36 of the 39 occurred in patients who had an intraoral operation combined with the neck dissection.† It is rather striking to note that in the group of advanced cases in which the carcinoma involved the buccal mucosa, alveolar process and even perforated the mandible, the operation in one stage combining resection of lymph glands and excision of the primary growth gave comparatively excellent results—judged on the five-year basis. All the tongue cases, on the other hand, gave very poor results both as to operative mortality and lasting cures. This is true where intraoral and neck dissection are combined in one stage. When the neck dissection is postponed, as I believe it should be, until there is reasonable assurance that the primary lesion is healed, the operative mortality is exceedingly low, only 5.7 per cent at Barnard Hospital in 52 cases and 3.6 per cent in 55 private cases.*

It may be noted that I have not stressed whether or not the cervical lymph nodes were palpable. This is because I do not regard palpability of the lymph nodes as any indication of the necessity for their removal. Almost every carcinoma of the oral cavity is accompanied by some infection of the tumor mass. This infection will of itself cause hyperplasia of the lymph glands to the point where they can be palpated and whereas the hyperplastic gland is usually softer than the gland enlarged from carcinoma I have learned that the sense of touch alone cannot be relied upon to differentiate hyperplasia from carcinoma.† My own experience with both irradiation and operation has led me to believe that reports of lasting favorable results from irradiation of metastatic glands have been based upon the effect of irradiation on palpable hyperplastic glands and not upon true metastases.

The technique of the radical operation is subject to some variation dependent upon what part of the oral cavity is involved in the primary growth. I feel it is of the greatest importance to observe two principles: the first, to remove as much tissue beyond that known to be involved as reason dictates—conservation of tissue at the expense of dangerous approach to cancer invaded areas has no place in any treatment of cancer; second, that surgical attack should begin at the periphery of tissue to be excised and end at the point of maximum involvement. There are only four in-

* The apparent discrepancy in figures is due to the fact that for the purpose of arriving at operative mortality all cases to January 1, 1932, are included. For the purpose of the estimation of five-year "cure", only cases to January 1, 1927, are considered.

† In a group of 50 private cases, on the other hand, on whom 65 neck dissections were performed, there were only 2 operative deaths and these occurred in the group of 55 neck dissections in which the oral cavity was not entered. No lip cases are included in this group.

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† For instance, of 38 private cases in which palpable glands were noted before operation, 26 on microscopic examination proved to be carcinoma and 12 hyperplasia. Of the lip group at Barnard Hospital, out of 35 cases in which the record mentions palpable glands only 11 showed carcinoma on microscopic examination. One case in which it is definitely stated no glands were palpable, carcinoma was found in the excised gland tissue.

violate structures in the triangles of the neck, the two common carotid arteries and the two vagus nerves. Both deep jugular veins may be removed with impunity (at different stages) and even one vagus may be severed. The degree of postoperative shock is governed by the time consumed in operating and the amount of blood lost. I have seldom found it necessary to resort to transfusion. Postoperative hemorrhage is the most feared complication. Loose closure of the very large wound with ample provision for drainage is the best preventive. The contraindications to the operation are: (1) a poor general condition of the patient, such as would contraindicate any major surgical procedure; (2) evidence of metastases below the clavicle or of recurrence in the primary lesion; (3) fixation of the metastatic mass to the spinal column, and (4) extensive skin invasion.

SUMMARY

The material for this study is comprised of 190 cases from the Barnard Free Skin and Cancer Hospital and 50 private cases. Every case had more or less radical resection of the lymphatic glands of the neck as part of treatment of some form of intraoral carcinoma, including carcinoma of the lower lip in the Barnard Hospital group. In many instances resection of the lymph glands was combined with an intraoral operation. In this group operative mortality will necessarily be high (20 to 25 per cent). The percentage of deaths from radical resection of glands of the neck alone is approximately 4 per cent. From a "five-year cure" standpoint analysis of both private cases and free clinic cases shows a striking difference in the numbers alive when no carcinoma was found microscopically in the excised lymph nodes. Of 30 cases without carcinoma in the glands from the free clinic 19 survived five years. Of 32 cases with carcinoma of the glands 8 were alive five years later. These are exclusive of lip cases. In 66 lip cases: of 40 without carcinoma 38 survived; of 16 with carcinoma 9 survived. These figures are based on records which are complete, and cases which died as a result of operation are excluded. They are not presented with any desire to show the results (good or bad) from treatment. The significant facts are that the percentage of cases alive five years in which neck dissections were done before the glands were involved is very much greater than in the cases where the glands showed carcinoma, which might be expected; and that of 48 cases in which carcinoma was demonstrated as having formed metastases in the cervical lymph nodes 17, or 35 per cent, were alive without recurrence five years later. These results cannot be approximated in the case of proved metastases to lymph nodes by any form of treatment other than radical surgery.*

* For discussion see page 248.

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CONSERVATIVE PROCEDURE IN THE CARE OF CERVICAL LYMPH NODES IN INTRAORAL CARCINOMA*

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THE cervical lymphatic system in intraoral cancer has demanded and received increasing attention for about three decades. The subject was first stimulated by the work of Butlin on carcinoma of the tongue in 1895. He advocated what we now designate as a partial dissection of the neck—the en bloc removal of tissues of the anterior triangle of the neck on the same side as the primary lesion. He advised this dissection whether or not metastatic nodes were palpable. This operative procedure was based on the hypothesis that the successful treatment of intraoral cancer depended as much on the care of the cervical lymphatic region as on the treatment of the primary lesion. When the results were not as good as anticipated, this surgical approach was amplified and extended, first by a complete unilateral dissection, and later by the dissection of the nodes of both sides of the neck. The complete unilateral or bilateral neck dissection has been the method of procedure in most surgical clinics for about twenty-five years. This operation has been done in those cases in which no nodes were palpable, as well as in those in which there were metastatic nodes in the operable stage. The only major variation has been the sequence of the operative approach, that is, whether the primary lesion was first excised followed either immediately or within a few days by the neck dissection, or whether the excision of the cervical nodes preceded the removal of the primary growth. There is no reasonable explanation as to why the latter method should be followed. The lymph nodes serve as a protective barrier, and if they are the first to be excised any cell emboli, consequent on the unavoidable trauma of surgery, may be deposited beyond the severed lymphatics where there is no restraint to growth, or the metastatic emboli may be sent to more distant locations where they are completely beyond surgical excision or beyond the reach of adequate irradiation. These considerations obtain either for the accepted and standard type of surgery or the more modern, but no more efficient electro-surgery.

When the patient with intraoral cancer is admitted to the hospital one of three conditions, other than the primary lesion, is presented in the condition of the cervical region. Either there are no palpable metastatic nodes in the neck, or the nodes are present but operable, or disease in the lymphatic system has so far progressed that it is beyond the scope of surgery. This classification is based on the surgical aspect alone. It does not take into consideration the grade of malignancy of the tumor which is also a very important factor, and will be mentioned later.

Absence of nodes presumably means there are no metastatic nodes. It is very common to find a lymphadenitis present due to an infected ulcerated primary lesion. The diagnosis is made primarily by the consistence of the node, that is, whether it is soft, firm, or hard, but the repeated palpation during the course of treatment of the primary is also of value because an inflammatory node may be tender, and varies in size, diminishing as the intraoral infection decreases. A metastatic node is hard, gradually increases in size and is not tender.

Metastatic nodes to be operable must be limited to the same side as the primary growth. They must be confined within the capsule of the node and also limited in their distribution to one chain of nodes, or at most, to those lymphatics in two triangles of the neck, namely, a submaxillary and

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upper part of carotid triangle. Inoperable nodes are those which have perforated their capsule and have infiltrated the surrounding tissue, or which have disseminated throughout the neck. Those nodes are also considered inoperable which are on the opposite side of the neck to the lesion, or both sides.

It is usually conceded in surgical clinics that those nodes are inoperable, the primary lesion of which is of a very malignant character, classified histologically in one of the three following grades: epidermoid carcinoma grade 3, transitional cell carcinoma, and the lympho-epithelioma. In our conservative method of treating the cervical region in intraoral cancer, other contraindications to radical surgery are included. These will be discussed under the treatment of inoperable nodes.

In the care of the cervical region of patients with intraoral cancer, we have maintained a policy of conservatism. On admission to the hospital both sides of the neck are subjected to external irradiation, which includes both the primary lesion and the regional nodes. This procedure is followed even when no nodes are palpable. The dosage and method of irradiation depend on the type of lesion and the location, that is, whether or not complete regression is expected from external irradiation alone. When interstitial irradiation of the primary lesion is indicated, this is done following the completion of the external irradiation. The patient is then observed frequently with special attention directed toward the region of the cervical lymphatics. This method is based upon the rational assumption that the cervical nodes serve as a protective mechanism to the spread of epidermoid carcinoma. It is an observed fact that the more adult type of cancer of the oral cavity metastasizes to one, or at most to a limited number of cervical nodes, which are a protective mechanism to the spread of cancer. This resistance to the growth of metastatic cancer cells seems to be more marked while the function of the node is unimpaired. Ewing has noted that there is in the lymph nodes a period of preparation for metastatic implantation, evidenced by diffuse hyperplasia, due to toxic or septic absorption. Thereby the resistance of the node is lessened in its ability to combat the cancerous emboli, either by its filtering capacity or its restraint of growth by encapsulation in fibrous tissue.

We do not know how many emboli may be destroyed in the lymph nodes, but it has been shown experimentally by Hellman that not all the metastatic emboli progress to tumor formation.

When the cervical lymph nodes are resected routinely, or for apparent metastases, the pathologist often reports in his findings a small focus of cancer in one of the nodes. Though such a report necessitates the recording of a metastasis, it is possible, had the dissection been done a few weeks later, that no cancer would have been found.

To the experimental data may be added the more practical and clinical observations that a large proportion of those cases admitted to the hospital without metastatic nodes in the neck will remain free of regional metastases throughout the course of the disease, whether or not the local disease or distant metastases progress to a fatal termination. It hardly seems justified to subject a patient to a major operation unless it is very necessary. By far the greater number of patients with intraoral cancer are in an advanced age, and are poor risks for radical surgery. Besides the toxemia which often accompanies the oral carcinoma, the general health is further impaired by undernourishment and fluid depletion. Painful mastication and deglutition are the most common symptoms of oral cancer, and are usually the only symptoms. The fluid depletion can be quickly overcome, but the undernourishment is a difficult problem in a debilitated patient of later life, when the recuperative power is diminished. The operative mortality following radical neck dissection has not been reported. Available statistics include those cases in which both the primary and cervi-

cal regions are operated upon, and the region most frequently studied is the tongue. This necessarily carries a higher mortality rate because of the local infection and the pulmonary complications which often follow. Morestin had a mortality of over 20 per cent in his series subjected to the combined radical operation for cancer of the tongue. Such a death rate is prohibitive to radical surgery. The same percentage will not be attained when the tongue is irradiated, and the neck dissection is the only surgery done, nor will the mortality be as high for surgery for carcinoma of other portions of the oral cavity; nevertheless the infrequency of cervical metastases strongly favors the conservatism which we have practiced in dealing with the regional lymphatic system in oral carcinoma.

I reported in 1927 a group of 983 cases of oral carcinoma admitted to the service without metastatic nodes, of which 79.9 per cent remained free of nodes during the period of observation, or for at least two years. Not all of these patients remained free of disease, and many died of either local disease, distant metastases, infection or intercurrent disease within the two-year interval. Nevertheless radical neck dissection would not have prolonged life in such cases, and besides the immediate mortality following operation, the surgical procedure would have lowered the general resistance both to the carcinoma and to infection, and thereby, in all probability, would have shortened the duration of life of the whole group.

Studied from another aspect, it is learned from this report that of the 1,363 patients in the whole group, 983, or 70 per cent, were admitted without palpable nodes, whereas 175 had operable nodes, and 205 patients presented inoperable nodes. If a neck dissection had been done on all cases except the inoperable group there would have been 1,158 surgical operations on cervical lymphatics, whereas only 372 patients had or developed operable nodes. It is a known fact that metastases occasionally occur on the side of the neck opposite to the lesion, or on both sides simultaneously, so this would again decrease the number of cases suitable for surgery.

New and Childrey recently reported that 32.2 per cent of their cases of cancer of the tonsil were free of cervical metastases when first admitted to the Mayo Clinic. But cancer of the tonsil manifests itself in the cervical nodes earlier and more frequently than any tumor of the oral group. This report does not give the proportion of the remaining 67.8 per cent that was operable or inoperable, but it may be assumed that many were in the latter stage. I found nearly one-third of all cases of carcinoma of the tonsil had inoperable metastatic nodes on admission to the hospital, and nearly half of all admissions presented no evidence of cervical metastases.

A detailed study in a surgical clinic of the cervical nodes in cases of carcinoma of the several regions of the oral cavity would assist greatly in determining the frequency of metastatic nodes, and help to reach a better agreement between general surgeons who care for a considerable number of cases of oral carcinoma and the group of the profession that is devoting all its attention to cancer therapy. Such a study would undoubtedly discourage the routine neck dissection.

Simmons has reported on this phase of the work. In 20 cases without palpable metastases, carcinoma was found in the nodes of 7 cases following excision, and the other 13 cases had no demonstrable metastases in the regional nodes. Since routine neck dissection is not done at the Memorial Hospital, we do not have any data on the frequency of metastatic cancer in the cervical nodes, when palpation does not reveal its presence.

Cases with operable metastatic nodes present no special problem, except the actual surgical technique. We all agree on the procedure to be followed, that is, the nodes should be surgically eradicated. When indicated, the dissection should be unilateral and complete, with removal of the contents

of the posterior as well as the anterior triangles, together with the sternocleidomastoid muscle and internal jugular vein. Bartlett has very ably and adequately described the surgical anatomy of the neck and the technique of neck dissections. But his indications for this procedure are too comprehensive, including, as they do, diseases with which even the most radical surgery cannot cope, namely, lymphosarcoma and Hodgkin's disease.

Lesser procedures must be carried out for very definite reasons, the most common one being age and debility in a patient with an adult type of primary growth and a single metastatic node. This exception is more applicable to cases with lesions of the anterior portion of the oral cavity, which are more apt to have metastases in the submaxillary region. Even in such cases, by a full submaxillary incision in the posterior region, the upper deep group of nodes can be easily excised. In this procedure the nodes over the carotid bulb must be included in the excised mass. Other than the nodes draining each individual region of the mouth, the carotid bulb node is the most frequently involved, though it is usually a secondary deposit from a regional node, that is, from the submaxillary node in anterior oral lesions, or from the upper deep cervical group in posterior oral lesions.

In all dissections, whether complete unilateral, or the limited type, before closing the wound, gold tubes of radon are buried in the locations where the lymphatic channels have been severed, especially where a recurrence is most likely to manifest itself.

The treatment of inoperable metastatic cervical nodes should be conservative. In surgical clinics where the physical agents, radium and roentgen rays, are not available, an attempt is made to eradicate advanced metastatic carcinoma by extensive surgery. It is the only means that can be offered for cure or palliation. At Memorial Hospital we do not attempt the excision of metastases in cases that offer practically no possibility of cure. In this class are included cases which present one or more of the following conditions: the carcinoma has perforated the capsule of the node and has infiltrated the surrounding tissue; the nodes are locally operable, but the primary tumor is very extensive and probably uncontrollable; operable nodes in debilitated patients unable to withstand surgery; cross metastases and bilateral metastases; recurrent nodes, and metastases from transitional cell carcinoma and lympho-epithelioma.

There are also the very advanced metastases from all histological gradations of primary lesions, which have progressed far beyond surgical eradication.

All the above types of cases are subjected to external irradiation on admission to the hospital. The more advanced cases, in which only the mildest palliation can be expected, receive only this type of treatment —external irradiation, the dosage depending on the general condition of the patient and the stage of the disease. Many cases of transitional cell carcinoma and lympho-epithelioma require and receive no other type of irradiation, though a few need the implantation of radon to attain the best results.

Patients with transitional cell carcinoma or lympho-epithelioma, when they are physically able to stand such treatment are given two or three skin erythema doses of external irradiation to each side of the neck over a period of two to three weeks, equally divided into daily doses. This dosage is usually sufficient to care for the local disease of these radiosensitive types of disease. If a localized nodule remains after the heavy external irradiation, this is treated by implanting the mass with gold tubes of radon.

The interstitial irradiation is done in one of two ways. In the advanced stage of metastases, the gold tubes are implanted directly through the anesthetized skin, being distributed uniformly throughout the mass. No attempt should be made to eradicate the disease totally when it has progressed so far that it is adjudged hopeless. The large volume of tissue precludes the

possibility of giving sufficient dosage, because the amount of radon required to deliver the lethal dosage to a tumor increases rapidly in larger masses. This is expressed in figures by the following comparison: to deliver 10 S.E.D. to a node 1 cm. in diameter, 2 mc. of radon is required, but if the mass is 6 cm. in diameter, 54 mc. is necessary to give the same dosage. The amounts are relatively larger for tumors of greater diameter.

Neither the surrounding tissue nor the patient can tolerate such large amounts of radiation.

There is also the danger of necrosis in the large masses, because the blood supply is already limited. The added trauma of the radiation is very likely to cause a massive necrosis, even without the presence of infection. The result of such necrosis is an ulcerated wound, with a neoplastic base. The infection then becomes uncontrollable, and the attempt to attain palliation makes the patient more uncomfortable and hastens his death.

The less advanced cases and also those considered inoperable for previously mentioned reasons, are first given external irradiation. Later, the patient is admitted to the hospital for surgical exposure of the mass for the implantation of radon. This method is much better for proper and accurate implantation of radon, which can be buried in the tumor under direct vision. Moreover, the stage of disease which lends itself to this form of therapy is more favorable, both clinically and physically. The node can be reached under local anesthesia with very little difficulty, and at the same time important blood vessels and nerves can be avoided. A gold tube too near a vessel may cause necrosis with consequent hemorrhage; one too near a motor nerve will cause paralysis of a nerve, or if too near a sensory nerve, intolerable pain.

A limited invasion of the skin by the neoplastic nodes does not prevent the exposure and implantation, because a portion of the skin can be excised in exposing the node, and after placing the interstitial radiation, the wound is either closed by undermining the edges, or the small defect is filled with antiseptic packing, and allowed to granulate. This latter method is to be avoided if possible because the intense radiation impedes the production of granulation tissue and may permit profuse growth of bacteria on devitalized tissue.

In this surgical procedure, the most careful asepsis must be observed. The carcinomatous tissue is a good culture medium, but devitalization by irradiation permits a vigorous growth of bacteria.

Since the conservative method has been applied to the inoperable nodes, the results have been markedly improved. This improvement cannot be learned altogether from a statistical study. It is more obvious from clinical observation.

Moreover, as experience is gained in the use of gold tubes, the inoperable group has been enlarged, until at the present time, the cases considered suitable for radical surgery seem to be reaching a minimum.

The following report is intended to be only a cross-section study of the types of cases admitted to Memorial Hospital. The years chosen for this study were 1925 and 1926. These years were chosen because it was in the first named year that radon in gold filtered implants was made available by Failla. They also permit the study of cases over a five-year period.

It must be remembered that we were not thoroughly familiar with the use of gold tubes at that time, and therefore the results are hardly comparable to the results we are now getting.

This analysis will be a group analysis of the 234 cases of microscopically proved lesions of the oral cavity—consisting of carcinoma of the tongue, tonsil, floor of mouth, inferior maxilla, mucosa of the cheek, soft palate, superior maxilla, and the antrum.

Of the 234 cases admitted to the hospital during the two years, 123 did not have palpable metastatic nodes, a percentage of 52.5 per cent, and of these 123 patients without nodes, only 29, or 23.5 per cent,

developed metastases. Sixteen of the 29 cases developed inoperable nodes, that is, the nodes were so located that radical dissection seemed contraindicated. The nodes were on the opposite side of the neck, on both sides, or there were distant metastases. In a few instances a long interval between observations because of carelessness or ignorance of patients permitted a metastatic deposit to progress beyond the operable stage. But such instances were a distinct minority, and are not sufficient to argue for a routine dissection, when all the figures are considered.

Only 46 patients were admitted with operable nodes, that is, a percentage of 19.6 per cent. To these may be added the 13 who developed operable metastases after admission, a total of 59 patients.

Of the 59 patients, a complete neck dissection was done on 37, and a partial dissection on 13. The other 9 patients either refused operation, were lost track of, or died before the operative procedure. The 13 partial dissections were those operations confined to submaxillary, and submaxillary and upper deep cervical group in poor surgical risks with a lesion of the anterior region of the mouth.

The presence of nodes brings up the question of diagnosis, that is, whether they are inflammatory or metastatic. In this series of cases only those cases proved by section in the operable group, were classified in this group. There were several cases clinically diagnosed as metastatic, but proved to be inflammatory when nodes were submitted for histologic study.

Metastatic node or nodes were diagnosed by palpation 67 times, and in 50 instances the diagnosis was verified. This is a percentage of 74.6. Simmons reported 22 cases clinically diagnosed as metastases, with a histologic verification in 12, or 54.5 per cent. The error in diagnosis is more frequent in Simmons' report, and will probably be so when further investigated, i.e., in the direction of safety, diagnosing inflammatory nodes as metastatic, rather than finding neoplastic emboli in unsuspected nodes.

A large percentage of patients were admitted with the cervical nodes in an inoperable stage. In this series there were 65 such cases, a percentage of 27.7. To the 65 with inoperable metastases is added the group developing inoperable nodes, 16 in number, totalling 81 cases, which constitute 34.6 per cent of the 234 patients.

As experience is gained, the operable group is constantly being decreased, and the inoperable increased. The relatively poor results of surgical treatment of operable nodes, compared with the improving results of the more conservative therapy of exposure of the nodes and insertion of radon, urges us to continue to treat more cases conservatively.

In the group of 81 cases of inoperable nodes, there are 5 free of disease for five or more years. These figures are for the group that would be classed inoperable in any clinic. It is certain that the later reports will show a much higher percentage as the earlier cases are included. I believe the percentage cures of the whole inoperable group, as classified on our present basis, will about equal the percentage cures of the operable group.

To properly evaluate the 6.2 per cent clinical cures in the inoperable cases, it is necessary to consider separately the several locations of the primary tumor. There are no five-year clinical cures in those patients having had carcinoma of the tonsil, floor of mouth, inferior maxilla, mucosa of cheek, antrum, or superior maxilla. The tonsil lesions are usually very malignant and metastasize widely, so that the control of the cervical region may be of no avail in attaining a five-year freedom from disease.

Lesions of the floor of the mouth and inferior maxilla often involve the local cervical region by extension, which makes the treatment more difficult. Moreover, sepsis is a frequent cause of death.

In those cases with lesions of the posterior portion of the cheek, superior maxilla and antrum, the primary growth is difficult to control, and the associated sepsis and bone necrosis are often the cause of death.

Of the tongue cases with advanced metastatic nodes, the five-year clinical cures amounted to 14.4 per cent, and there were 27 such cases, so the percentage figure is quite reliable.

The 20 per cent cure in soft palate carcinomata is based on only 5 cases. This lesion is usually very malignant, and cervical nodes appear bilaterally in 50 per cent of all cases. (This figure is based on a larger series of cases previously reported by me.)

These analyses are sufficient in themselves to indicate a continuance of the conservative policy of treating the cervical lymphatic system in intraoral cancer. This conservatism is applicable both to the groups of cases without cervical nodes, and to those with advanced inoperable metastatic nodes. The clinical observations of the improved results in the later cases, since greater experience has been gained in the use of gold tubes, are a further incentive for conservative therapy. I am sure that the figures of a later date will prove this to be a well founded opinion.

CONCLUSIONS

1. A large proportion of the cases with intraoral carcinoma are admitted to the hospital without metastases to the cervical lymph nodes.

2. Very few patients admitted without cervical lymphatic metastases develop metastases in that region.

3. The cases without cervical metastases, and those with inoperable metastases constitute most of the cases admitted to the hospital.

4. Palpable nodes in the cervical region are often hyperplastic nodes. Differential diagnosis is difficult.

5. Errors in diagnosis are more apt to be made in diagnosing hyperplastic nodes as metastatic, rather than metastatic nodes as hyperplastic.

6. Operability of the cervical nodes is determined not only by stage of the metastases, but also by the grade of malignancy of the primary lesion.

7. Conservatism is maintained at Memorial Hospital in the care of patients without cervical lymphatic metastases, and the field of operable nodes is being narrowed as experience is gained in the use of gold tubes in the advanced and borderline cases of cervical metastases from intraoral carcinoma.

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DISCUSSION ON PAPERS BY BLAIR, ET AL., STEWART, FISCHEL, AND DUFFY

DR. EDWIN C. ERNST, St. Louis, Mo. I think all of us who have been following these very interesting discussions have made occasional mental reservations of at least a few doubtful conclusions reached by the essayists.

The treatment of choice, whether surgery or radiation in the type of malignancy under discussion after eliminating the primary lesion, in my opinion continues to remain at least a debatable question.

The surgical attack of this problem has been presented most convincingly by the essayists. The motion pictures by Dr. Fischel describing the operative technique necessary in these cases in the treatment of the metastatic cervical nodes does stimulate one towards conservatism as a routine procedure of such heroic measures. Nevertheless, we must eventually face the facts and if the end-results in our future statistics justify such an extensive operative removal of cervical nodes in all cases, greater emphasis must necessarily be placed in that direction without qualification.

I am inclined to feel that many of us as radiologists are reluctant to be as positive as the surgeons have been this morning since we realize that there remain for analysis a multiplicity of undeveloped problems. For example, the question of the relative degree of potential malignancies in palpable or doubtful glandular cervical indurations is important from a therapeutic as well as a statistical standpoint. In reporting cures by the radiation method these factors must be taken into consideration.

Many other factors complicate the correct analysis or true evaluation of the treatment of choice in the average type of lesion. Greater consideration must be given the individual case, the pathological findings, the possible anatomical distributions. The hospital type of cases that have been discussed by Dr. Fischel are certainly the most difficult groups to analyze and treat and this is equally true of other free cancer institutions. This condition only adds to our present complications and difficulties in arriving at the true evaluation of the preferred method of attack.

My personal experiences in the treatment of the local malignant lesions have led me to prefer with a few exceptions radiation therapy methods. With reference to the subsequent control of the glandular metastasis, the individual case and the attending complications will always remain the deciding factors in my estimation as to which method or methods should be employed, surgery, irradiation or a combination of both.

If there is any doubt or indecision as to the treatment of choice of potentially malignant glandular cervical metastasis, I always retain an open mind and frequently advise a block dissection.

We must remember in all of this work and the treatment of these conditions that the proper selection of the type or method of application of radium or roentgen rays or a combination of both must be given due consideration. The histological phases of the lesion to be treated are factors of equal comparative importance. Incomplete surgery may produce widely different end-results not unlike indifferent irradiation methods.

In recent years, however, irradiation methods have steadily improved to the extent that at least the immediate results have shown progress in the effectiveness of this method and future analytical observations of the actual correlated and comparative results will help us eventually to better evaluate the various therapy methods and their specific indications.

DR. GEORGE W. GRIER, Pittsburgh, Pa. Those of us I think who have been attending meetings of the American Radium Society regularly for the last fifteen years must realize that we are gradually making progress in the treatment of oral cancer. When we started in this field some fifteen years ago it was debated whether radiation was the proper treatment for the intraoral lesions. This morning after listening to the surgeons it seems that practically all primary cases are suitable for radiation therapy. We have practically reached the stage where we almost assume that the cure of the primary lesion is to be expected, and we all recognize that the treatment of the metastases is the most difficult part of the problem.

Now we come to two different types of cases, one in which we cannot recognize any definite type of metastasis, and it seems that both the surgeon and the radiologist think we should use his method of treatment. I was rather surprised to hear the surgeons say that in those cases in which we cannot recognize enlarged glands they believe radical surgery should be used. Perhaps if we radiologists would take this view we might improve our results considerably. Certainly in

those cases in which we cannot palpate glands we are apt to treat them less intensively, and if we would treat these cases the same as we do those with known metastases perhaps we could increase our good results. My experience is that most of the poor results are due to under-treatment. Unless we follow Coutard's line of treatment we cannot carry out this radical work, but I think we might approximate his idea by Pfahler's idea of saturation therapy. I have been carrying out this idea more and more, with decided improvement in cases in which cervical metastases are evident. I think this is the line along which we should try to improve our results. We should treat our patients much more intensively than we have in the past. We are at a disadvantage when we attempt to argue with surgeons on this, because we have no definite proof that the cases we have cured were malignant whereas the surgeon has that proof. The only thing we can do is to go ahead and treat these cases to the best of our ability and attempt to prove that our method is effective.

Dr. Charles L. Martin, Dallas, Texas. Since I took a firm stand in favor of irradiation for cancer of lip in a paper read before this Society yesterday, I feel impelled to enter this discussion. I cannot quote statistics in the short time allotted to me here but a careful study of 119 of our own cases over periods varying from five to ten years has convinced me that just as many primary malignant lesions on the lip can be cured with efficient irradiation as with surgery. Irradiation is the method of choice because it has a decided economic advantage and gives cosmetic results that cannot be produced by any other therapeutic measure.

Many misconceptions have arisen relative to the value of block dissections of the neck in lip cancer. Surgeons have a great deal to say about their good results in dissections where no glands are palpable. In our own series of cases no surgical procedures on the neck were attempted on any patient without palpable glands but the percentage of patients alive for five years is almost identical with that claimed by some of our best surgeons who did block dissections on every case. The percentage of patients cured by neck surgery after the glands have become involved is exceedingly small and we believe that Quick's rules covering the indications for the operation constitute the best guide now available. There is a certain mortality attached to radical neck dissections and in my opinion they are done much too often.

Dr. William H. Cameron, New York City. In discussing the relative merits of surgery and irradiation in cancer, we should remember that modern surgery is an old and well-established form of treatment—a single form of treatment—while modern irradiation, practiced for about two decades, assumes many forms. I may make this statement because, during the first fifteen year period in radium therapy, the radium used was indiscriminately measured—a fundamental error that cannot be overlooked—and because surgery, as a rule, is weighed against radium as though radium were also a single agent.

Generally speaking, radium therapy has, during its comparatively short therapeutic history, proved its worth in radiosensitive malignant lesions and, if this is true, why risk operation in this particular group? On the other hand, why subject lesions to intensive irradiation in cases that are proved to be radioresistant? If we must have a controversy, why not over the best method to use in determining whether the individual lesion is or is not radiosensitive?

Dr. Albert Soiland, Los Angeles, Calif. The Radium Society has been honored by having three of America's distinguished plastic surgeons contribute to its scientific program. I doubt if anyone in the world could have excelled the brilliant surgery which has been so graphically demonstrated. However, I cannot refrain from taking issue with Dr. Blair in what I believe to be the unnecessarily drastic surgery in cancer of the lower lip. Many of us have seen a great number of patients with just as serious involvements as those shown here today, alive and well from ten to twenty years after radiation treatment, and, I must add, with considerable less disfigurement than shown by the examples which have just been presented. We cannot, of course, get along without surgery, but it would seem best to effect an intelligent coalition such as that at the New York Memorial Hospital, where teamwork and cooperation between the pathological, physical, surgical, and radiation departments have achieved results which are second to none.

Dr. Burton J. Lee, New York City. I feel greatly indebted to Dr. Blair and Dr. Fischel for their presentations. We who arranged the program thought it would be enlightening to have these two excellent plastic surgeons in the country present their work. If I had an oral carcinoma with metastatic nodes and had Dr. Blair or Dr. Fischel available I would be

tempted to submit myself to either of them for operation, but these men are exceptional. The excellent work done by Dr. Martin in proving the histology of nodes by aspiration biopsy is in constant use at the hospital. The biopsy is done with an 18 gauge needle and a Record syringe under novocain anesthesia, and a histologic diagnosis can be made in three or four minutes. As Dr. Duffy pointed out, the palpable node which is hard and the one which is soft should be differentiated clinically. In the so-called transitional cell carcinoma, which is highly radiosensitive, irradiation often cures the disease.

To decide whether surgery alone, or surgery combined with irradiation is the method of choice in treating metastatic cervical nodes, one thousand cases treated by experts such as Dr. Blair and Dr. Fischel, should be placed side by side with a thousand cases treated by the other method. This Society should stimulate and support an analysis of the clinical end-results of a large series of cases treated by these two methods.

DR. BLAIR (closing). I realized when I accepted your very flattering invitation that what I had to present would be far from generally acceptable. To save any misunderstanding, I will repeat that unless there is some special contraindication in the particular case, it is our practice and teaching to make a routine radical removal of not only the lymph nodes but also of the lymph-bearing tissues of the associated drainage area either subsequent to or at the time of destruction of a squamous epithelioma of the lower lip, tongue, cheek, floor of mouth, lower gum, nasal or oral pharynx. This removal, however, does not necessarily include the lymphatic vessels between the primary lesion and the related nodes. After hearing Dr. Martin's presentation, you might think we would consider ourselves licked and quit, but we are not yet quite ready to give up. Ordinarily I will, in a discussion, avoid any direct attack on any statement made on the floor, but I feel called upon now to indulge in an exception to this rule. For many years I have regarded Dr. Burton Lee as the most outstanding man we have today engaged in therapeutics of cancer, and it was partly because this invitation came through him that I accepted it. I believe the suggestion which he cited, namely, to aspirate a possibly cancerous node, to be absolutely unsurgical, that a negative microscopic finding would be without meaning, and that the procedure itself is not without grave risk to the patient if the gland is cancerous. The propriety of watchfully waiting on the behavior of lymph nodes may be a matter for discussion, but it is my firm belief that trauma to these nodes, less than absolute removal, might be very dangerous. Too often we have seen quiescent cancerous nodes light up after an injury, surgical or otherwise, to regard it as a coincidence, and we must not forget that the infection in these nodes can lie dormant and inevident for quite a number of years after the primary growth has been eradicated.

I believe some of those who did me the honor to discuss my paper missed the fact that all but two of the cases shown had been previously treated elsewhere by irradiation. We have a number of such cases sent to us just as you have unsuccessful previously operated cases sent to you.

DR. STEWART (closing). I enjoyed very much the presentations by Dr. Blair and Dr. Fischel, and the motion picture of Dr. Fischel's was very impressive; perhaps a little too impressive. If a patient were to see it he would never have the work done. I think when we are dealing with cancer if that type of operation gives a sufficient percentage of cures it is justifiable. Dr. Fischel was not very definite in his statement of percentage cures in the cases with glandular metastases, and the only one who will give definite statistics is Bloodgood. He reports only 10 per cent five-year cures when the glands are involved from intraoral malignancies. I am not sure that routine radical operation with only a 10 per cent chance of cure is a justifiable procedure. I feel that we should be a little more conservative and reserve operation for those cases in which there is a more resistant type of tumor. As Dr. Grier brought out, we have relied too much on too limited dosage. I think most of us agree that the roentgen treatment as used three years ago, for instance, would not control neck metastases. We must give more intensive external irradiation and if this is not sufficient reinforce it by implanting radium into the nodes.

As all the preceding speakers have objected to Dr. Blair's surgical treatment of carcinoma of the lip, it would appear that I am following the lines of least resistance by doing so. That is not the case. I would be untrue to my practice and beliefs should I sponser surgery for carcinoma of the lip. However, some of the advanced local lesions we excise with cautery and the repair is done by Dr. Blair's method.

A factor that must not be forgotten is that complete removal of cervical lymph nodes is impossible and recurrences following radical surgery are common. Therefore a prophylactic neck dissection is a farce. Irradiation is more logical for prophylaxis. If nodes develop in radioresistant carcinoma they should be removed widely. The radiosensitive and inoperable nodes must be treated by irradiation.

I am therefore forced to conclude that cervical metastasis, like cancer anywhere else, is not a problem for surgery or radiology. It requires the combined efforts of all medical science and then leaves much to be desired.

Dr. Fischel (closing). I do not consider biopsy by the puncture-aspiration method applicable to cervical lymph nodes suspected of containing metastatic cancer. Cervical lymph nodes often contain infectious material and puncture of the lymph gland capsule may easily spread the infection. Also, one gland negative for cancer does not mean all glands are free.

Considering the whole discussion, it seems to me just as rational to do a complete surgical removal for cancer of the mouth as anywhere in the body. Whenever we can get at the lines of spread of cancer through lymphatic channels and can take them out without danger no one questions the correctness of the complete operation. In cancer of the breast no one removes the breast and leaves the axilla alone, and I think it is just as bad treatment for cancer of the lip to treat the primary lesion and leave the nodes of the neck alone.

I was accused of not giving statistics on metastases. I believe such as they are they will be found in the body of my article. My series, as well as I could analyze it, showed 25 per cent of five-year cures in cases of proved metastasis to lymph glands of the neck. I think if I had 15 such cases alive for five years after operation the significant thing would be that *they* at least were alive regardless of the total number of cases treated.

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Eighteenth Annual Meeting: Chicago, Ill., Sept., 25–30, 1933.

EDITORIALS

REPORT OF COMMITTEE ON THE COSTS OF MEDICAL CARE

ITS SIGNIFICANCE TO THE MEDICAL PROFESSION

THE recently published report of the Committee on the Costs of Medical Care is of special interest to the medical profession. This interest arises not only because of the possible effect of various recommendations upon the practice of medicine but especially because of the direct and indirect effects upon the public welfare which adoption of some of the recommendations would undoubtedly produce. Widespread attempts are to be made to put into effect some of the recommendations of the majority of the Committee, especially those which propose the reorganization of the medical profession into groups and those which advocate the payment for medical care through insurance.

It was only on these two questions that there was radical divergence of opinion within the Committee. There was unanimous agreement upon the necessity for strengthening and extending public health activities, for certain changes in medical education and for coordination of medical services in each state and local community. The medical profession will undoubtedly lend its influence and support to movements to put these recommendations into effect. The profession has always maintained leadership in the prevention of disease and in matters of medical education. Charges have been made that medicine is ultraconservative and unprogressive. Its conservatism has been manifested particularly in combating the use of nostrums and the activities of quacks. Such conservatism has repeatedly saved the people from exploitation. The tremendous progress of the science and art of medicine in the past fifty years is sufficient refutation of the charge of unprogressiveness. The charge has arisen because the medical profession insists upon careful scrutiny of changes in the methods of caring for the sick. The profession is especially concerned that new methods or procedures be founded upon the sound basis of past experience or upon careful experimentation. At the present moment many new methods of medical practice are under trial in various parts of the United States. It is apparent that many of them are simply types of contract practice extended to larger blocks of the population than heretofore and many of them with the added danger of a lay-controlled corporation in charge of medical practice. It has been demonstrated by innumerable experiments that contract practice, as usually carried on, is degrading to the medical profession, contributes nothing to medical progress and results in an inferior grade of medical care. The majority report of the Committee on the Costs of Medical Care offers essentially this solution for the future. They recommend, first, that the medical profession be organized into groups, and, second, that these groups furnish medical care through some type of contract with groups of laymen, the service to be financed through insurance.

The first recommendation of the Committee is as follows: "The Committee recommends that medical service, both preventative and therapeutic, should be furnished largely by organized groups of physicians, dentists, nurses, pharmacists, and other associated personnel. Such groups should be organized, preferably around a hospital, for rendering complete home, office, and hospital care. The form of organization should encourage the maintenance

of high standards and the development of preservation of a personal relation between patient and physician."

It is clear both from the wording of the recommendation and from the explanations in the text that the Committee contemplates a system of practice quite different from that carried on by what has been understood heretofore as group practice. Under this recommendation the entire medical profession is to be concentrated into groups, preferably very large groups, in medical centers. The Committee's statement with regard to this is as follows: "The Committee's most fundamental specific proposal is the development of suitable hospitals into comprehensive community medical centers, with branches and medical stations where needed, in which the medical professions and the public participate in the provision of, and the payment for, all health and medical care, with the professional aspects of the service under the control of professional personnel."

This plan has the familiar aspects of so-called big business organization. There is little in the present state of industry or the economic situation of the world to make it seem desirable to extend into the management of the professions those methods which have been in operation in industry and business. "Organization" has been almost a fetish in the business and industrial world but the medical profession has not been generally attracted to its worship. The following paragraph from the minority report of the Committee on the Costs of Medical Care probably represents the attitude of most of the medical profession on this subject: "The medical center plan is the adoption by medicine of the technique of big business, that is, mass production. It seems almost impossible for those who are not engaged in the practice of medicine to understand that the profession of medicine is a personal service and cannot adopt mass production methods without changing its character. It is always the individual patient who requires medical care, not diseases or economic classes or groups. The neglect of this principle in other fields has brought serious evils that are now being corrected only with great difficulty."

An important fact which should always be considered in connection with plans for group practice and group payment is the well established one that about 80 per cent of all illnesses are simple in nature and can be adequately treated by a general practitioner without the aid of specialists or elaborate apparatus.

Another fact that has been overlooked by the majority of the Committee on the Costs of Medical Care is that multiplication of clinics and groups in large cities inevitably results in providing expensive equipment far beyond the communities' needs. Every additional group must have its specialists with all necessary equipment for their use even though the city may already be well supplied with such equipment. The minority of the Committee said with regard to this: "It serves no good purpose to reduce overhead in individual clinics if the total cost to the community is increased through duplication of plants." The views of the minority on the subject of group practice were summarized in the following paragraph:

"The minority recognizes the advantage of group practice under certain conditions, especially in communities where practically all of the physicians can be joined in one, or at the most, in two groups. It does not believe that group practice offers any real solution to the problems of the cost of medical care except under very restricted conditions. The dangers of group practice are already apparent and the advantages either to the medical profession or to the public are limited."

The other recommendation of the Committee which caused disagreement and which has created much discussion is as follows: "The Committee recommends that the costs of medical care be placed on a group payment basis, through the use of insurance, through the use of taxation, or through the use of both of these methods. This is not meant to preclude the continua-

tion of medical service provided on an individual fee basis for those who prefer the present method. Cash benefits, i.e., compensation for wage-loss due to illness, if and when provided, should be separate and distinct from medical services."

The insurance plan favored by most of the majority was of the voluntary type. A few were in favor of immediate state control of medical practice through compulsory types of insurance.

The minority report makes the following statement relative to voluntary types of insurance: "It seems clear that recommendations for further trial and expansion of voluntary insurance schemes in the United States are entirely inconsistent with the Committee's own findings. To recommend that our own country again experiment with discredited methods of voluntary insurance is simply to ignore all that has been learned by costly experience in many other countries as well as in our own. Voluntary insurance systems are now in operation in many parts of the United States and are increasing in number and in size. In many places these schemes are being operated in accordance with the plan recommended by the majority of the Committe, that is, by making contracts with organized groups of the medical profession. That they are giving rise to all the evils inherent in contract practice is well known. Wherever they are established there is solicitation of patients, destructive competition among professional groups, inferior medical service, loss of personal relationship of patient and physician, and demoralization of the professions. It is clear that all such schemes are contrary to sound public policy and that the shortest road to the commercialization of the practice of medicine is through the supposedly rosy path of insurance."

With regard to compulsory types of insurance the minority group made the following statement: "The objections to compulsory health insurance are almost as compelling to this minority group as are those to voluntary insurance. The operation of every form of insurance practice up to the present time has resulted in a vast amount of competitive effort on the part of practitioner groups, hospitals, and lay controlled organizations. Such competition tends to lower the standards of medical care, degrade the medical personnel, and make medical care a business rather than a profession. Proof of this is at hand in our own experience in this country with the only compulsory system with which we have yet had to deal, workmen's compensation insurance. The results named above are prevalent in many states. This is the rule to which there are a few notable exceptions. Under workmen's compensation, groups are soliciting contracts, often through paid lay promoters; laymen are organizing clinics and hiring doctors to do the work; standards of practice are being lowered; able physicians outside of the groups are being pushed to the wall; the patient is coerced by his employer to go to a certain clinic; and the physician is largely under the control of the insurance companies. These are not visionary fears of what may happen but a true picture of widespread evils attending insurance practice. We should need no better example of what must happen to medical care if compulsory insurance is extended to families."

The minority report under its recommendation for "Development by State or County Medical Societies of Plans for Medical Care" offers the following safeguards which should always surround any plan to distribute the costs of medical care: (1) It must be under the control of the medical profession; (2) free choice of physicians; (3) must include all, or a large majority, of members of the county medical society; (4) the funds must be administered on a non-profit basis; (5) patient must pay directly a certain minimum amount before insurance becomes operative; (6) must make provisions for community care of indigent; (7) must be separate from plans for cash benefits, and (8) must not require certification of disability by the physician treating the disease or injury.

Under such safeguards the minority recognizes the value of trial of plans by county medical societies to distribute the costs of medical care. It seems important that such plans, under the initiative and control of the medical profession, should be gotten under way as rapidly as possible. Otherwise the insurance plans already in operation, in many cases in the hands of lay corporations organized for profit, and plans being promulgated by certain members of the majority of the Committee on the Costs of Medical Care will take the matter entirely out of the hands of the organized medical profession. It cannot be stated too emphatically that the organized profession must take constructive and aggressive action in this matter. There is probably nothing of greater importance before it at the present time. Plans are being promulgated by sociologists, economists and business men who have little knowledge of medical care and by health officers and—medical employes of foundations who are out of touch with the problems of the individual care of the sick, which if put into effect will operate to the detriment of both the public and the medical profession and will greatly interfere with medical progress.

The medical profession needs a unified, constructive program based upon those principles which were agreed upon by the majority and the minority of the Committee on the Costs of Medical Care with the addition of important recommendations set forth by the minority. Among the latter none are of greater importance than that which would restore the general practitioner to his rightful place in medical practice.

The issue is very definitely drawn. On the one hand, we are to have the entire medical profession and all others engaged in medical care organized into groups furnishing medical care under contract to groups of laymen; at first they are to be permitted to operate under voluntary insurance but later and inevitably compulsory insurance and state control are to prevail. On the other hand is the method described in the final summary of the minority report of the Committee, as follows: . . . "medical care by the individual physician with the general practitioner in a central place; with groups and clinics organized only where the nature of the situation and character of the personnel render such organization a natural development; with elimination of wastes in our present methods and coordination of all existing agencies; with careful trial of new methods based upon sound experience; and with adoption of insurance methods only when they can be kept under professional control and destructive competition eliminated; all this through a well-organized, untrammelled medical profession true to the great traditions and ethical standards of the past."

ARTHUR C. CHRISTIE
Member of Committee on Costs of Medical Care

W. ARTHUR LAFIELD
1881 - 1932

DR. W. Arthur LaField, Professor of Radiology at Yale University Medical School and President of the Connecticut State Medical Society, was found asphyxiated in his New Haven apartment, Monday, December 26, 1932. It has been given to few in a life span of half a century to effect without show or pretense such genuine accomplishment in one's life work as Dr. LaField achieved for roentgenology.

Born in Stratford, Connecticut, in 1881, his parents early moved to Bridgeport where he obtained his public school education. He began the study of medicine at the University of Vermont but due to the influence of his stepfather, Dr. C. A. Collard, a homeopath, he transferred to the New York Homeopathic Medical College from which he was graduated in 1905. Following an interneship he engaged in general practice for six years when he commenced the serious study of roentgenology as clinical assistant in that specialty at the New York Postgraduate Hospital (1912–1914) then

becoming assistant at Bellevue Hospital (1915).

Meanwhile he became roentgenologist to the Bridgeport Hospital where his work gained wide recognition. He was the first radiologist to my knowledge in a general hospital to have a self-contained department in a private pavilion, where were housed the roentgen diagnostic equipment, high voltage roentgen therapy apparatus, radium emanation plant, examining and treatment rooms for ambulant cases as well as a ward for bed cases.

All therapy cases were examined by him personally, the kind and amount of radiation prescribed and given by him when possible and the patient's convalesence followed in his own ward, an ideal arrangement perhaps only possible in a small hospital but certainly not even there without initiative and vision. Because of his leadership the Bridgeport Hospital (350 beds) has had since 1926 a gram of radium in solution available for charity as well as pay cases. The hospital learned that this purchase of radium not only placed it in the forefront of many institutions pretending to care for malignant disease but that it was a sound investment as well.

I have stressed the therapy side here because when Dr. LaField was organizing the radiation clinic at the Bridgeport Hospital it took courage and foresight to establish a plant for the care of malignant disease that looked to the opposition on a scale commensurate with a special cancer institute.

While having a particular penchant for therapy he was constantly alert to progress in roentgen diagnosis. In 1926 he was made Director of Roentgenology and Radium Therapy at the Bridgeport Hospital with his office associate, Dr. Berkley Parmelee, as assistant. He then launched an educational campaign among the members of his own state society for the recognition of roentgenology as a section, which became an accomplished fact in 1929, and Dr. La Field was the section's first chairman. He was instrumental as a committee member in drawing up minimum standards for roentgen laboratories acceptable to the American College of Surgeons.

In 1928 he was asked to become Clinical Professor of Radiology of the School of Medicine at Yale University and Radiologist in Chief of the New Haven Hospital and the New Haven Dispensary, which he accepted. In preparation for his work he made an extended visit abroad to the important teaching centers of Paris, London, and Stockholm. Of his work at Yale, Dean Winternitz has written me as follows:

"We were all very much devoted to Dr. LaField who had found what we thought was a most happy opportunity for him and for us here at the School of Medicine. He joined our faculty in 1928. At that time the section on radiology was at a low ebb. The quarters were inadequate, the equipment even more so, and the staff was very small. Fortunately, we secured funds to construct a new clinic and service building shortly after Dr. LaField came, and largely through his vision a very splendid part of the building was secured for radiological activities. Subsequently this was equipped in the most modern fashion, and we believe it represents a very satisfactory physical facility to meet all sorts of needs in connection with x-ray diagnosis and therapy.

"Dr. LaField instituted a wide variety of educational opportunities in his field, including not only medical students, but also the house officers and the upper staff, with the result that many and more able students sought the chance of further work in this branch under Dr. LaField as internes, assistant residents, and residents. Conferences between different sections of the clinical departments were arranged, and through this means the broader viewpoints of medicine and the function of radiology in association with the general fields of diagnosis and therapy were advantageously illustrated and elaborated. Obviously, the department was well organized and on a sound economic basis.

"Dr. LaField had won the affection and admiration, not only of his colleagues in the

School of Medicine, but also of the entire profession in the State as was evidenced by the fact that he was President of the Connecticut Medical Society at the time of his death."

One of his former assistants at Yale writes: "Although Dr. LaField published little during his life, he accomplished more for the radiologic profession in his four and one-half years at Yale than is generally known. Incidentally, he gave the best elective course in radiology offered to undergraduate medical students in the United States—namely, nine hours weekly for six weeks. During two years' observation I noted that ninety-six per cent of the graduating classes voluntarily took his course."

Dr. LaField had a buoyancy of spirit that was infectious and had to an unusual degree the faculty of camaraderie. He was a thirty-second degree Mason, a member of all the important scientific societies and of many social clubs.

Despite his apparent cheerfulness these later years his heart was heavy, known only to a few intimates. His end was tragic proof that material emolument and intellectual preferment are not self satisfying, He is survived by a widow and three children and a legion of friends. His heart knew nothing of the narrowness of race or creed. He was in the best and finest sense, human. Ave atque vale!

Frederick W. O'Brien

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Chicago, Ill., Sept. 25–30, 1933.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Chicago, Ill., Sept. 25–30, 1933.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Milwaukee, Wis., 1933.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual meeting: Chicago, Ill., Sept. 25–30, 1933.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, Dr. D. R. MacColl, 2826 S. Hope St., Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Richmond, Va., November, 1933.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.
Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. M. A. Thomas, Medical Arts Bldg.
Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. L. M. Hilt, Myers Bldg., Springfield, Ill.
Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next Meeting, University Hospital, Ann Arbor, Mich., May 27, 1933.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn. Next meeting, Minneapolis, Minn., February, 1933.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.
Three meetings a year—January, May and November.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Reiley, Clearfield, Penna.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thomson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. L. Warren, Strong Memorial Hospital.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY
Secretary: Dr. R. B. Taft, 105 Rutledge Ave., Charleston, S. C.
Meets at time and place of South Carolina State Medical Association. Next meeting, Spartansburg, April, 1933.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Virginia Roentgen Ray Club
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Societe de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April in different German cities, at least once in five year in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Maracine 30 Bucarest, Rumania.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

Society of Medical Radiology of Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. H. Scheuermann, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Meets first Tuesday each month, October to July.

Orient

Japan X-ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

PROGRESS AND PROSPECTS OF ROENTGENOLOGIC DIAGNOSIS IN RELATION TO SURGERY AND CLINICAL MEDICINE

Late in 1895 came Roentgen's announcement of his discovery of roentgen rays, which brought to vision an aid scarcely second to that afforded by the microscope. Then began a stupendous advance in the diagnosis and treatment of disease of man.

At the outset, employment of the roentgen rays in medicine was a separate and special art. Roentgenological examination, with its savor of mechanics, was somewhat beneath the dignity of physicians of the old school, and its early applications were relegated to lay tinkers with electricity or photography and to a few physicians who found pleasure in the study of electric and actinic phenomena. These men were the first roentgenologists. But soon every physician was imbued with the desire to make use of this diagnostic agent which, from all accounts, must be simple to use and probably capable of exhibiting the internal structures of the body as clearly as the furniture in a room can be seen through an open door. Thousands of physicians installed roentgenological equipment. Disillusionment followed speedily. Generating apparatus was capricious, and vacuum tubes were temperamental. To produce a roentgenogram, a tediously long exposure was required. Roentgenograms were disappointing; scarcely more than the outline of the bones could be seen; internal organs and soft tissues cast a confused aggregation of shadows which defied separate identification.

Apparently the game was not worth the candle, and most machines were consigned to the attic. Thus, roentgenology was handed back to its pioneers, who continued faithfully to carry on. Today their names stand out vividly on the medical roster.

About 1910 the efforts of these pioneers began to yield conspicuous results. The medical world awoke to the realization that the roentgen rays were good for something more than to disclose the presence of fractures and foreign bodies. From that period on, roentgenological diagnosis bounded forward. Now, whatever the diagnostic problem may be, roentgenological examination is almost certain to be invoked for its forthright solution, for confirmation of the clinical opinion, or for the revelation or exclusion of hidden complications. Withal, let it be noted well that with few exceptions the achievements and capabilities of roentgenology are due to the efforts of men who have applied themselves persistently and solely to this line of endeavor—roentgenologists.

In view of its progress in the past, there would seem to be little reason for concern as to the future prospects of roentgenology. Nevertheless, most of its practitioners, including those who are not apprehensive as to their personal welfare, regard the general outlook with anxiety, for they are doubtful that the integrity and efficiency of roentgenology will be maintained. In too many instances the roentgenologist apparently is still regarded as a supertechnician rather than as a medical consultant. Too often his work, both technical and interpretive, is subjected to irksome supervision by his clinical and surgical associates. From every quarter he sees invasion of the roentgenological field threatening partition of its domain. Many surgeons, clinicians, and specialists prefer to employ roentgen rays directly, or make their own interpretations, or entrust technicians with diagnostic responsibility, even when competent roentgenologists who could render better diagnostic service are at hand. As a further affront, many young but thoroughly trained roentgenologists are driven by circumstances to accept full time employment at an extremely modest salary in certain open hospitals which appropriate all profits from the department although professional opinion now effectually bars similar employment of a surgeon, internist, or otolaryngologist. Moreover, by permitting any such practice in the roentgenological department, other specialists may be preparing a like future for themselves.

If it be granted that the foregoing conditions are widely prevalent, non-roentgenologists would perhaps offer the following pleas in justification: Roentgenology is not properly a specialty, for it covers virtually the entire field of medicine. To practice it efficiently the roentgenologist would need to be a universal specialist. Its foundations are not only too broad but also too shallow. Roentgenological data alone are not sufficient for diagnosis but must be construed in the light of the clinical facts. With his superior knowledge of these facts, the clinician has an advantage in interpretation. In essence, roentgenological diagnosis is not analytic and rational but empiric and pictorial. Its funda-

mentals are simple, standardized, widely published, and readily available to all. If equipped with a knowledge of them or with merely an atlas, the clinician should not require expert assistance in diagnosis. In short, the roentgenologist is a superfluous intermediary, for no one can gainsay the right of any physician to use roentgen rays, and he should learn to employ them just as he has learned to use other means to aid his vision.

To all such claims the roentgenologist would oppose an emphatic dissent and might argue as follows: Roentgenology represents a logical division of labor in the evolution and higher organization of medical science and art. It has the same tripartite foundation that underlies all medicine and all specialties in medicine; namely, anatomy, physiology, and pathology. A thorough understanding of these basic sciences as related to roentgenological phenomena is indispensable. Its efficient practice necessitates instruction and experience at least equivalent to those required for the practice of any other specialty. It is not true that clinical data enter primarily and inevitably into roentgenological interpretation, nor is it true that advance acquaintance with the clinical facts in a given case will assist the roentgenologist in the discovery or exclusion of disease. On the contrary, his prime task is a study of anatomy, physiology, and gross pathology as depicted by shadows and shadow-defects, regardless of symptoms and physical signs. His study is not merely pictorial and comparative but highly analytic, and roentgenological advancement has been achieved almost exclusively by this method. Through repeated humiliations he has learned that foreknowledge of clinical facts will bias his judgment and lead him too often into error. In this factor he sees an insuperable obstacle to reliable roentgenological diagnosis by the clinician, and he holds it accountable for a large proportion of current mistakes. He freely admits that clinical facts are often necessary for differential diagnosis, but in such instances he is confident that the best results will follow a review of their respective data by the roentgenologist and clinician in personal conference. For these reasons the roentgenologist feels strongly that to distribute his province among other specialties would be atavistic, degenerative, and a futile repetition of history.

Thus the issue is joined, an issue without rancor or bitterness but none the less an issue. It must be and will be settled without regard for the dignity, fame, or emolument of any person, group or guild, for the spirit of trades-unionism has no place in it. It would doubtless determine itself in the natural evolution of medicine. If roentgenologists have been remiss in acquiring and maintaining the proficiency rightfully expected of them, if realities are lagging too far behind ideals, or if competent roentgenological diagnosticians are still too few, the condition should be corrected. But whether a proper settlement shall be forwarded or retarded depends not only on the roentgenologists but also on the attitude of the profession of which they are a part. The fact that an issue exists at all is conclusive proof that neither group fully understands the other, and a program of mutual enlightenment should be inaugurated. This done, holding fast to the high purpose of all medical endeavor, a fair and final solution will be well on its way.—B. R. Kirklin. (Editorial.) *Surg., Gynic. & Obst.*, January, 1933, *56*, 120–122.

To the Editor:

May I offer the following suggestion which you may possibly wish to publish?

I have found that by using red cellophane, or a like substitute, between the bulb and lens of a flashlight, a handy instrument is available for use in the fluroscopic room. Overhead meters can thus be read without the necessity of bright lights and the insertion of rectal tubes for enemata is simpler. The intensity of the light can be varied by the number of layers of cellophane used.

William S. Altman
Beth Israel Hospital
Boston, Mass.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, 105 Rutledge Ave., Charleston, S. C.

A SIMPLE ROENTGENOSCOPIC ATTACHMENT

By O. R. TROJE, M.D.
FAIRFIELD, ALABAMA

THE attachment consists of an easily constructed cassette holder to be used for roentgenographic or serialographic examination of the gastrointestinal tract in conjunction with the roentgenoscope, with or without compression. It is hung on the fluoroscopic screen and can be easily shifted in the horizontal plane, the screen itself taking care of the vertical adjustment. It can be easily attached or removed. The figures are self-explanatory. A sheet of metal of the desired thickness (galvanized sheet roofing will do) is cut to the dimensions as indicated in Figure 1, and then folded to the shape as shown in Figure 2.

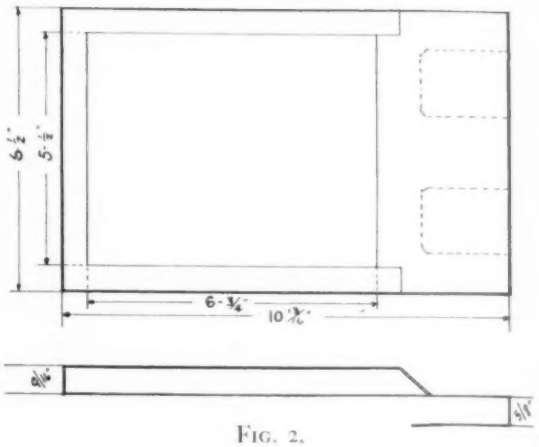

Fig. 2.

The dimensions are for a 5″×7″ Buck X-Ograph cassette which is an excellent size for serial roentgenography of the pyloric region. The back being cut out of the holder, the area to be roentgenographed can be exactly centered. The spark gap and

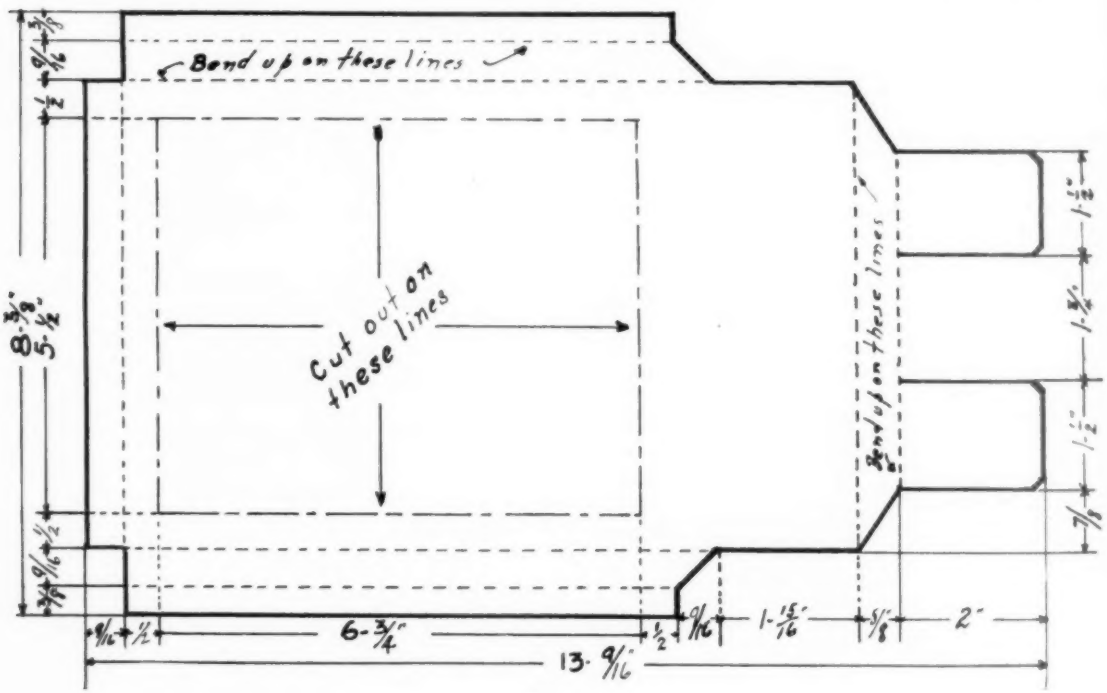

Fig. 1.

milliampere settings are then stepped up to the proper roentgenographic intensity, the cassette is dropped into the holder and the exposure made. Any number of exposures can be made in rapid succession, depending on the number of loaded cassettes at hand. The involved area can also be easily viewed from time to time between exposures, so that the roentgenoscopist can show on the film exactly what he sees on the screen. The usual serialographic mechanisms are expensive and cumbersome. The advantages claimed for this cassette holder are simplicity of construction, economy, and efficiency with no complicated mechanism. The usual hospital mechanic can make one in twenty minutes at a cost of not more than fifty cents. A bakelite front is a refinement but not necessary, and is optional. It costs about a dollar more to add this.

We have been using this accessory for some time, and have materially reduced film expense and improved our service.

A CEILING MOUNTED TUBE FOR TWO METER STEREOSCOPIC FILMS OF THE VERY SICK PATIENT

By O. O. FEASTER, M.D.
ST. PETERSBURG, FLORIDA

IT IS frequently desirable to have 2 meter films of the chest of an individual who is too sick to stand in front of a cassette changer. Either the roentgenograms are taken at a shorter distance, or with the patient in the erect position, with the result that he becomes faint, or faints.

At very little expense the ceiling mounted tube carrier shown in Figure 1 was devised. The patient lies on a 14″×17″ cassette tunnel and satisfactory 2 meter stereoscopic roentgenograms are readily made.

The ceiling bracket is made of 3/4 inch angle iron. The track is 30 inches long and allows for longitudinal centering of the tube, as well as for the stereo shift in the long axis. A portion of a yardstick lies adjacent to one of the tracks to accurately gauge the shift between the first and second exposures.

There is a minimum of 18 cm. high tension clearance in all directions, which is ample on equipment used solely for diagnostic work. The legs of the ceiling bracket are of such length as to give a 2 meter target film distance.

The tube holder is from an old tube stand. Grooved rollers are attached to the base mounting to insure easy movement of the tube. The assembly is installed above one end of the roentgen table.

FIG. 1.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

Berven, Elis. Die radiologische Behandlung der malignen Tonsillentumoren. (Radiological treatment of malignant tumors of the tonsils.) *Strahlentherapie*, 1931, *42*, 113–135.

The author discusses the material treated at the Radiumhemmet in Stockholm, consisting of 42 cases of carcinoma treated from three to twelve years ago and 8 cases of carcinoma treated in 1930, 4 cases of lympho-epithelioma, 35 of sarcoma and 5 of malignant mixed tumors. In all of the cases that have remained cured more than three years the diagnosis was verified microscopically. He divides the cases into three stages. In stage I the regional glands are not palpable, in stage II they are palpable but movable and in stage III there are inoperable or bilateral metastases. The results of treatment are much better in stage I than in stage II and in stage II than in stage III.

From 1919 up to 1924 the patients were treated with roentgen rays followed by the local application of radium but the method used since then has given better results. It consists of distant radium treatment followed by local application of radium tubes to the surface of the tumor or insertion of radium needles, supplemented by endothermy. The apparatus used consists of 6 tubes each containing 5 mg. radium element arranged in a circle with a total filtration equivalent to 5 mm. lead. The distance from the skin is 6 cm. Generally 3 or 4 fields are used: one on the throat on the same side as the tumor, one at a corresponding place on the other side of the throat, one on the nape of the neck and one on the cheek on the same side as the tumor. An average of 6 gram-hours is given for thirteen or fourteen days, making a total of between 80 and 90 gram-hours to a series. This brings about a reaction similar to Coutard's epithelitis. Another series is not given until the reaction from the first has passed off and the tumor no longer decreases in size. This as a rule is about four to six weeks. The later treatment is determined by the size and nature of the tumor, the age and general condition of the patient and the size and position of what remains of the tumor. It may consist of further teleradium treatment, application of tubes to the surface of the remaining tumor, insertion of needles or removal with diathermy.

With the old technique from 1919 to 1924 they treated 28 cases of carcinoma. There was no improvement in 57.1 per cent, improvement in 17.9 per cent, temporary cure with recurrence and death in less than three years in 25 per cent and cure for over three years in none. Fourteen cases of carcinoma and 4 of lympho-epithelioma were treated by the new technique with no improvement in 22.2 per cent, improvement in 22.2 per cent, temporary cure with recurrence and death in less than three years in 16.7 per cent and cure for more than three years in 38.9 per cent. In this group there was primary cure in 55.6 per cent, freedom from symptoms for one year or longer in 50 per cent, for two years or longer in 44.4 per cent and for over three years in 38.9 per cent.

The sarcomas were treated with a combination of roentgen irradiation and local application of radium. The patients were given 1 to 1 1/2 skin erythema doses on one or both sides of the neck in the course of one or two weeks, an effort being made to bring about slow and gradual disappearance of the tumor with as little reactive inflammation of the surrounding tissues as possible. The radium was applied during or immediately after the roentgen treatment in cases of small tumors without metastases and after about a month in large tumors. Among the 35 sarcoma cases there was no improvement in 17.2 per cent, improvement in 11.4 per cent, temporary cure with death from recurrence in less than three years in 28.6 per cent and cure for over three years in 42.8 per cent. There was primary cure in 71.4 per cent, freedom from symptoms for one year or longer in 48.6 per cent, for two years or longer in 48.6 per cent, for three years or longer in 42.8 per cent and for more than five years in 36.7 per cent. The percentage of primary cures is strikingly high. Surgical operation and even exploratory excision is dangerous in sarcoma of the tonsils.

Malignant mixed tumors of the tonsils are comparatively rare. They can be operated on easily in the early stages but show a marked tendency to local recurrence so extirpation by endothermy is preferable to that by the knife.

Mixed tumors are not very radiosensitive and the only successful method is teleradium treatment. About 20 gram-hours was given on the same side as the tumor by the same technique as for carcinoma. In 3 of the cases the tumors decreased in size until they could be operated on by diathermy. These patients are alive after 4, 4 3/4 and 5 years. The other two did not respond to the treatment.

Malignant tumors of the tonsils and syphilis often coexist. Differential diagnosis is very difficult but most important as tissues injured by syphilis do not bear radiotherapy well.—*Audrey G. Morgan.*

Salinger, Hans, and Thiel, Rudolf. Die Wirkung der Röntgenbestrahlung des Sympathikus auf das Auge. (The effect of roentgen irradiation of the sympathetic on the eye.) *Strahlentherapie*, 1931, *42*, 96–112.

The authors irradiated the sympathetic in normal individuals and in glaucoma patients to test the effect or roentgen irradiation on the vegetative nervous system. They found that after unilateral irradiation of the ciliospinal center and the superior cervical ganglion the pressure curve of both eyes in glaucoma patients showed a typical course. There was a preliminary rise followed by a fall for several days and then another gradual rise. The pressure curves of the two eyes ran parallel, that is the pressure curve for the non-irradiated side was the same as that for the irradiated side. There were only slight variations in pressure in individuals with normal eyes. Protrusion of the eyeballs and dilatation of the pupils were seen as signs of irritation of the sympathetic. These signs may be considered evidence of the influence of roentgen rays on the vegetative nervous system.—*Audrey G. Morgan.*

Dormann, Annemarie. Ergebnisse der Röntgenbestrahlung bei Knochen- und Gelenktuberkulosen an der Chirurguschen Universitätsklinik Kiel (1918–1927). (Results of roentgen treatment of bone and joint tuberculosis at the Surgical University Clinic of Kiel from 1918 to 1927.) *Strahlentherapie*, 1931, *42*, 201–218.

The statistics of a surgical clinic are hardly comparable with those of a tuberculosis sanatorium as too many factors enter into the results. Roentgen treatment was used only as a supplement to surgical and general treatment and it was sometimes difficult to evaluate the part played by the different factors. Up until 1923 as hard rays as possible were used with a filter of 3–4 mm. aluminum and a dose of 10–15 x (a skin erythema dose is about 25 x). In children sometimes only 5 x was given measured by the Sabouraud-Noiré method. This dose was repeated 6 or 8 times at intervals of four weeks; in the second year the intervals were longer. In many patients 10–15 irradiations were given in the course of two or three years. After 1923 the dose was reduced, 0.5 mm. zinc and 1 mm. aluminum being used as a filter. This gives 20–30 per cent of a skin erythema dose at a sitting; children were sometimes given less.

Tables are given showing the details of the results. There were good results in 17 out of 24 cases of tuberculosis of the wrist joint, 13 out of 20 of tuberculosis of the ankle joint, 13 out of 20 of the elbow joint, 23 out of 44 of the knee joint, 3 out of 5 of the shoulder joint, 7 out of 17 of the hip joint, 34 out of 46 of the small bones of the hand and foot and spina ventosa, 21 out of 28 of various bones including the ribs, sternum, long bones and clavicle, 4 out of 10 of the pelvis and 4 out of 6 of the skull.

There were very few injuries that could be attributed to the rays. In one case there was intense atrophy of the skin with a tendency to ulceration. In one case in which a little girl was irradiated the breasts failed to develop and a eunuchoid condition in one man may have been caused by irradiation in childhood. In the earlier years there were some cases of skin atrophy and telangiectasis, but none of these have been seen since the dose was reduced.

In some of the cases it was difficult to estimate the value of roentgen therapy and there was only a general impression of improvement, but in many cases there was definite objective evidence of improvement due to the irradiation. The author believes irradiation is a valuable supplementary method of treatment in tuberculosis of the bones and joints and that with proper technique injury can be prevented.—*Audrey G. Morgan.*

Epstein, A. A. Über die Komplikationen bei der Radiumpunkturbehandlung des Zungenkrebses. (Complications in radium puncture treatment of cancer of the tongue.) *Strahlentherapie*, 1931, *41*, 341–358.

During the author's early experience in the

Oncological Institution of Leningrad severe injuries were often seen in the treatment of cancer of the tongue because of the too energetic use of radium radiation. Since the dosage has been reduced the more serious of these complications have been avoided in most cases. In order to avoid complications, the tongue and the whole mouth should be carefully cleansed before the radium needles are inserted and any carious teeth removed. In protracted radium puncture treatment special protective prostheses are required. The doses should never be larger than the normal energy dose, which for small and medium-sized tumors with the use of 0.5 to 1 mm. platinum filters is 1.2 to 1.5 millicuries-destroyed to 1 sq. cm. of irradiated surface and for large tumors 1 millicurie-destroyed. Platinum filters with walls 1 mm. thick are to be preferred in protracted puncture treatment to ones with thinner walls. In order to avoid hemorrhage in deep ulcers, if the radium carriers are left in a long time, care should be taken not to use too large amounts or too long needles or tubes, and if hemorrhage occurs the external carotid or lingual artery should immediately be ligated. Radium puncture alone is adapted only for small or at most medium-sized tumors. In large tumors combimed radium treatment from outside and electrocoagulation is to be preferred; with puncture treatment too large amounts of energy have to be used and they may lead to severe complications. If there is very pronounced cachexia no form of radium treatment should be used.—*Audrey G. Morgan.*

MISCELLANEOUS

DIETRICH, A. Ueber das Wesen der Bösartigkeit. (The nature of malignancy.) *Strahlentherapie*, 1931, *40*, 1–12.

The author concludes that malignancy cannot be explained either on the basis of a purely cellular theory or on that of a bacterial origin. Recent work in cultivation of cells and studies of cell metabolism do not support the purely cellular theory of malignancy. The cell is no longer considered the ultimate unit of the body, but a system of ultimate units (protomeres). The organism is built up by lower units of form (histomeres) uniting to form higher units (histosystems), preserving internal harmony of form and function. The parts of the body, the tissues, organs and organ systems, can only be considered in their relation to the whole. This is true under both normal and pathological conditions. Tumors are excluded from this harmony of the body. They are foreign elements or enemies. Benignancy or malignancy is manifested in morphological, chemical and functional properties. There is no one element that stamps a tumor as benign or malignant, but only a combination of them. The condition of the body, too, may have a stimulating or inhibiting action on tumor development, so that benign and malignant are not absolute conceptions. There are typical benign tumors that may become malignant under certain circumstances and cancers may be benign.

There is no treatment that acts exclusively on the local newgrowth without any repercussion on the whole body, affecting the neighboring tissues and circulation and the interrelation of the different systems of the body. In radiotherapy particularly a strictly-cellular conception is impossible. In addition to acting on the tumor and body cells it acts on the vascular and nervous systems.

All of these are purely theoretical considerations but practice ultimately depends on our understanding and interpretation of scientific problems.—*Audrey G. Morgan.*

CHRISTIE, ARTHUR C. The relation of radiology to other branches of medical practice. *J. Am. M. Ass.*, May 23, 1931, *96*, 1747–1749.

While radiology is the youngest branch of medicine it is a specialty sufficiently broad to engage all the talent and energy that any man can bring to it and should be given the same status as is given to other specialties. In small communities it may be necessary for radiology to be combined with other practice, and acceptable work may be done by men who avail themselves of all possible sources of training and information. The limitations of such a small practice must be kept in mind.

Radiology as practiced by other specialists is inefficient due to lack of training, tendency to rely on fluoroscopy alone or incomplete study, and poor quality of technical work under their supervision. These more than offset the convenience to physician and patient of the combined examination. Careful analysis shows the cost to the patient to be even greater.

Loose relationships between radiologist and clinician encourage commercial laboratories with their pernicious and demoralizing schemes and there are indications that these are being

extended to other branches of medicine. Radiologists should be consultants with careful training and broad experience. Fees should be charged accordingly and a charge based on the number of films taken is inexcusable.

The reasons for limiting the practice of roentgen diagnosis to the radiologist apply even more forcibly to the field of radiotherapy. Best results are usually secured when the radiotherapist has both roentgen rays and radium at his command.—*E. W. Hall.*

Desjardins, Arthur U. The status of radiology. *J. Am. M. Ass.*, May 23, 1931, *96*, 1749–1753.

Radiology has advanced more in the last decade than any other branch of medicine and promises to continue to do so. Successful practice of radiology requires thoroughly trained physicians. Commercial laboratories operated by lay technicians give pseudoradiologic service, harmful and inefficient, and are enabled to do this by the patronage of physicians who are ignorant of good roentgen practice, fancy they are saving their patient money, or obtain a percentage of the fee charged.

Radiological practice in many hospitals is inferior, due to the tendency toward employing young, poorly trained radiologists at a low salary to replaced experienced men, and also the tendency to hire technicians to do the work under the loose supervision of disinterested private practitioners or specialists in other lines. Trying to make the radiological department carry the costs of other departments is a rash and unsound policy.

High grade radiotherapy is a rare commodity. Too much emphasis is placed on equipment and not enough on the well-trained man. Better teaching should be provided, and more men of high ability must be attracted to the specialty. Radiotherapy must be taught equally with diagnostic procedure as the highest grade of work is done by men skilled in both branches of radiology. Few specialists in other branches of medicine ever acquire sufficient knowledge to become technically expert in radiology and work done by them is done on a lower level than by the radiologist.—*E. W. Hall.*

Pancoast, Henry K. Safety for radiologist and patient in diagnostic and therapeutic radiology. *J. Am. M. Ass.*, May 23, 1931, *96*, 1757–1760.

Radiation dosage, as in the case of any therapeutic agent destructive to life and tissue, must be carefully controlled. In high voltage therapy first, second, or third degree reactions, including changes from a mild erythema to those manifested by loss of the epiderm are not always desirable but are often permissible in deep therapy to attain the desired therapeutic result. Fourth degree or chronic ulceration is always to be avoided, and is usually the result of accident, although susceptibility may in some instances play a part.

The use of a protected tube, a suitable aluminum filter and attention to the number of exposures is sufficient to safeguard the patient in roentgenographic work. Fluoroscopy is more uncertain and dangerous and the operator must be guided by experience in using factors difficult to control.

In therapy filter control is most important and filters should be checked by automatic devices as well as by two persons who sign the treatment record. Time should be checked by at least two clocks or a timing switch and clock.

The operator is protected in proportion to the efficiency of the protective devices. Lead partitions, lead gloves, and lead aprons should be used. Test films should be frequently carried, blood tests made twice a year, and a four weeks' vacation be given every operator each year.

Suitable insulation and protective devices against high tension leads are essential to the safety of operator and patient.

Anesthetics are always a source of danger where roentgenologic equipment is used.

Distance is the best protection against radium rays. Heavy lead shields and long forceps give partial protection. Rotation service for radium workers is advisable.—*E. W. Hall.*

Mulsow, Frederick W. Roentgen carcinoma and sarcoma of man with report of a case. *J. Am. M. Ass.*, June 13, 1931, *96*, 2030–2031.

This case report concerns a physician who had rather severe dermatitis following exposure to roentgen rays incidental to fluoroscopic work. A nodular growth occurred on the index finger which was amputated and a diagnosis of spindle cell fibrosarcoma made. About a year later he developed a typical roentgen-ray carcinoma on the middle finger of the same hand, the diangosis being confirmed microscopically. Roentgen injuries are seldom

followed by sarcoma in man. The occurrence of both types of lesions in one individual is extremely rare.—*E. W. Hall.*

ASTI, MARIO L. Nuovi accorgimenti di tecnica in curieterapia. (New technical aids in radium therapy.) *Radiol. med.*, June, 1931, *18*, 786–791.

The author describes and illustrates a new type of support for radium tubes to be used in Columbia paste molds. The useful characteristics of this support are its solidity, the rapidity with which it can be put in place and its stability.

He then describes the method of standardizing the ionization chamber in the ionomicrometer of Danne and Mallet which has been modified by closing the anterior window and illuminating it by means of a small lamp placed against the posterior window. He then shows a standard with removable branches for suspending paste-molds and a support for the ionomicrometer which makes it possible to move it in any direction and locate it anywhere. —*Audrey G. Morgan.*

AHLBOM, HUGO. A new method of localizing foreign bodies in the eye. Teleradiography with visualization of the cornea. *Acta radiol.*, 1931, *12*, 212–235.

The author presents a brief summary of the more important methods described in the literature for roentgenographic localization of foreign bodies in the eye. He then gives an account of a new method which is based upon the taking of two images in planes at right angles to each other, one of them being a profile picture with the cornea visible. Both the pictures are taken with a focus-plate distance of 2.75 meters. The cornea is rendered visible in the lateral view through an aluminum wedge being placed between the patient's eye and the cassette. The patient is seated during the examination and special measures are adopted to enable the investigator to control the direction of the line of vision during exposure. As an extra safety measure, the principle of the so-called physiological method, that is, change of the direction of vision, is applied. The localization is carried out directly on wet films with the aid of patterns which are drawn on transparent film, using direct measurement with a pair of compasses. No so-called contact markers need to be attached to the eyeball.—*Audrey G. Morgan.*

LYSHOLM, ERIK. Device for ventriculography. *Acta radiol.*, 1921, *12*, 305–309.

The author describes a device for ventriculography which makes it possible to make the injection of air and do the roentgen examination on the same table. Both the table and the roentgen tube are movable in all directions, so the air can be made to occupy exactly the space most suitable for any desired projection. The device can be used for fluoroscopy as well. It is illustrated.—*Audrey G. Morgan.*

SCOPESI, MARIO. Misure ionometriche nelle Radium-epilozioni. (Ionometric measurements in radium epilation.) *Radiol. med.*, July, 1931, *18*, 857–864.

The author claims that the Photoradiotherapeutic Institute of the University of Florence was the first to use radium epilation as a means of treatment in mycotic diseases of the scalp. They have been using it for eleven years and have treated about 600 cases in this way.

He describes the method of applying the radium by means of a cap of stiffened gauze moulded to the patient's head, containing radium preparations of 5 mg. each filtered through 1 mm. of brass. With this filtration hard beta rays can be used. These are placed at a distance of 6 cm. from each other and 1 cm. from the scalp. Each preparation is fixed on a hexagonal rubber plate which, in addition to fixing the preparations at the proper distance from each other, acts as a secondary filter. The whole epilation dose is administered in forty-eight hours, the scalp being divided into two fields each one of which is irradiated for twenty-four hours. About 60 mg. radium element is used, though it varies somewhat according to the size of the scalp.

The results obtained by this method are compared with those of roentgen epilation and the results of ionometric measurements in the two methods given. The author concludes that radium epilation is indisputably superior to roentgen epilation and to roentgen-thallium treatment. Its advantages over those methods are that the emission of radium is practically constant, that there is a greater distance between the epilation dose and the erythema dose, and that epilation is always perfect no matter what the shape of the skull and how restless the patients are. It also has the advantage of simplicity of technique. Therefore radium

epilation is indicated in the very cases in which proper epilation with roentgen rays would not be possible on account of asymmetry or malformation of the skull, age of the patients, psychic condition, etc.—*Audrey G. Morgan.*

Willms, Elisabeth. Röntgenbestrahlung und Cholesterinspiegel im Blutserum. Colsil und Röntgenkater. (Roentgen irradiation and the cholesterin content of the blood serum. Colsil and roentgen sickness.) *Strahlentherapie*, 1931, *42*, 171–180.

Levy-Dorn and Burgheim found a decrease of the cholesterin content of the blood serum after roentgen irradiation associated with roentgen sickness. Burgheim concluded that the loss of cholesterin was the cause of the roentgen sickness and reported good results from treatment with colsil. The author tested these results. She did not find that the fall of cholesterin content after irradiation was constant nor did she find that the effect of colsil on roentgen sickness was uniform. In spite of a rise of cholesterin content following colsil 4 patients had severe roentgen sickness. She concludes that there are other metabolic factors involved in roentgen sickness besides the cholesterin content of the blood and various other remedies besides colsil are justified in the attempt to prevent roentgen sickness, such as calcium, glucose injections and salt solution. There is probably a subjective element in roentgen sickness also and any treatment given may have a suggestive effect.—*Audrey G. Morgan.*

Kotschneff, N. P. Radonwirkung auf den Blutzucker verschiedener Gefassgebiete und seine Verteilung zwischen Formelementen und Plasma. (The effect of radon on blood sugar in different vessel regions and its distribution between the cells and plasma.) *Strahlentherapie*, 1931, *41*, 359–369.

The author performed "angiostomy" on dogs by the method devised by Prof. E. S. London. For details of the method he refers to the work of London. Cannulas were introduced into the portal vein, hepatic vein and renal veins of dogs and the portal vein and renal veins of rabbits, and the blood sugar content studied. It was found that the introduction of radon into the stomach or intestine during carbohydrate digestion causes a very considerable rise in blood sugar in all vessel regions. The considerable increase in alimentary hyperglycemia after the introduction of radon into the stomach and intestine and the slight increase on the introduction of radon into the blood is accompanied by decreased sugar retention on the part of the liver and muscles and increased sugar retention by the kidneys, in the period of carbohydrate digestion. In fasting dogs, too, increased sugar retention by the kidneys was found after large doses of radon. The amount of sugar absorption from the intestine was very little changed in dogs by the action of radon; in fed rabbits there was increased absorption of sugar from the intestine after small doses of radon. Apparently the increased alimentary glycosuria after the administration of radon is not brought about by increased absorption from the intestine but chiefly by decreased sugar retention by the liver and muscles.

The introduction of radon into the stomach, intestine and circulation during fasting and during digestion increases the plasma sugar content and decreases the relative cell sugar content in all vessel regions. During fasting after the introduction of radon less plasma sugar and more cell sugar is retained by the intestine, and the liver and kidneys also retain considerably more corpuscle sugar. Under normal conditions relatively more sugar is taken up by the blood corpuscles than by the plasma during carbohydrate digestion. The introduction of radon at this time causes a general increase of sugar in all vessel regions with a decrease of the relative amount of plasma sugar excreted by the intestine and a decrease of the cell sugar excreted by them. This decreases sugar retention by the liver, as the liver, both before and after the introduction of radon, gives off only plasma sugar into the circulation during carbohydrate digestion and retains only corpuscle sugar. The kidneys too at this time retain much more cell sugar than plasma sugar. The introduction of radon after feeding bread causes a considerable decrease of sugar retention by the muscles, cell sugar being retained almost exclusively.—*Audrey G. Morgan.*

Flinn, Frederick B. Elimination of radium salts from the human body; preliminary report. *J. Am. M. Ass.*, May 23, 1931, *96*, 1763–1765.

Radium salts are eliminated very slowly from the body, some persons requiring from three to ten years to eliminate one microgram. Some observers have found rapid elimination to take place during the first few days. Administration of parathyroid extract has been

shown to hasten elimination of radium salts. The author has employed viosterol for this purpose with very striking results. Several cases are reported in which a relatively large radium content in the body, the largest being 90 micrograms, was materially reduced after months of administration and in 2 cases of less amount all has been practically eliminated. Some cases are still under treatment and the prognosis is believed favorable.—*E. W. Hall.*

CALLERIO, GIOVANNI. L'azione dei Raggi x sul sistema reticoloendoteliale. (Action of roentgen rays on the reticulo-endothelial system.) *Radiol. med.*, June, 1931, *18*, 768–785.

General irradiation of the whole body in white rats with doses of 1/2, 2/3 and 1 erythema dose caused marked changes in the cells of the reticulo-endothelial system of the liver and spleen. The intensity of the lesions varied depending on the size of the dose. There was intense proliferation of the reticulo-endothelial cells both in the liver and spleen. In the latter organ they showed a tendency to invade the Malpighian follicles, replacing the normal cells of the follicles until there was an entire change in their histological structure. While these lesions were visible even in animals killed a few days after the irradiation, in those kept alive for more than a month the histological structure of the spleen was completely changed. There was great decrease of the pulp and the follicles disappeared, being replaced by reticulo-endothelial cells. The megakaryocytes showed a certain degree of radiosensitiveness with marked signs of degeneration. The use of stains either before or after irradiation did not seem to be of any special value in differentiating the reticulo-endothelial cells.—*Audrey G. Morgan.*

VIVIANI, RODOLFO. Influenza di radiazioni x sulla secrezione gastrica du istamina in soggitti normali ed in gastro-pazienti. (Influence of roentgen irradiation on gastric secretion from histamin in normal subjects and patients with disease of the stomach.) *Radiol. med.*, June, 1931, *18*, 723–768.

There is still a great deal of discussion in regard to the effect of roentgen rays on gastric secretion. The discrepancy in the results of different authors is due largely to the different ways in which they have applied the rays. But sometimes with the same technique of irradiation the results have been different so there must be some important biological factor that affects the results.

The author therefore in his experiments used histamin to test the function of the stomach. In 12 subjects he studied gastric secretion by the fractional method both fasting and after the use of histamin. He used 2,600 to 3,600 R (Solomon) in 7 or 9 applications, separated by intervals of two days with 2 kv., 2 ma., focus distance 30 cm. on gastric and dorsal fields with a filter of 0.5 mm. zinc and 4 mm. aluminum.

He comes to the conclusion from his work that in a large proportion of individuals, both normal and with stomach disease, roentgen irradiation causes a real inhibition of histamin secretion, especially the secretion of acid and pepsin. Generally the inhibition is transitory but in some cases it persists for some time. In one subject it lasted for six months.

On analyzing the mechanism of the secretory action of histamin, it is evident that the changes in secretion caused by irradiation are due to direct action of the rays on the cells of the stomach mucosa. Some patients respond more readily to irradiation than others but there is some response in nearly all of them. There is no great difference in the effect on normal individuals and those with stomach disease, but the action is perhaps a little more intense in subjects with hyperchlorhydria. This work shows that irradiation may be used therapeutically in hyperchlorhydria, and for the purpose of decreasing secretion, especially qualitatively.—*Audrey G. Morgan.*

FREUND, FRANZ. Experimentelle Grundlagen der Röntgentherapie entzündlicher Prozesse. (Experimental basis of roentgen treatment of inflammation.) *Strahlentherapie*, 1931, *40*, 333–339.

It seemed to the author better to use traumatic inflammation for experimental purposes than inflammation of bacterial origin. One of his pupils made incision wounds 10 cm. long on the backs of rabbits and irradiated one-half of them with a relatively large dose, 8 H, or 400 R, with 3 ma. and 170 kv. He has demonstrated experimentally that inflammatory cells do not migrate to the site of the inflammation in the blood but that they are formed locally from the connective tissue cells of the blood vessels. In his cases roentgen irradiation inhibited exudation and decreased the number of inflammatory cells. In the irradiated half of the wounds the

traumatic inflammation was considerably less and healing took place quicker.

In inflammation pus cells are either evacuated or destroyed by absorption or phagocytosis. Other cells either persist and cause chronic inflammation or become re-transformed into connective tissue cells, which brings about healing. The action of roentgen rays may destroy pus cells more quickly and re-transform inflammatory cells into connective tissue cells. Biologically considered, this is a depressive action as inflammatory cells are of a higher stage functionally than connective tissue cells. If there are highly virulent bacteria in a focus of inflammation caution is necessary in irradiation as, for example, in tuberculous foci. The more chronic the inflammation the larger the dose it is safe to use. As every inflammation is really a local proliferation of cells the chief difference between neoplasm and inflammation is that in the latter the cells may be re-transformed into normal cells, while tumor cells have lost this capacity.

There is always an early erythema after roentgen irradiation in inflammation, showing greater permeability of the vessels in the irradiated area. Evidently the curative action of roentgen rays is due to this greater permeability of the vessels which makes it possible for larger amounts of protective substances to be brought to the focus. Experimental results show that as much as 75 per cent of an erythema dose may be necessary to re-transform the inflammatory cells to normal ones. The best irradiation is with hard rays and zinc filtration, but as it is not always possible to tell whether there are adhesions it is better to give the dose in two parts with an interval of three to six days between. Even when there is apparent healing a somewhat smaller dose of 40–50 per cent of an erythema dose should be given after about a month. Recurrences are due to the capacity of the connective tissue cells for becoming re-transformed into inflammatory cells. This capacity can be destroyed by irradiation.—*Audrey G. Morgan.*

WALTERS, O. M., ANSON, B. J., and IVY, A. C. The effect of x-rays on the thyroid and parathyroid glands. *Radiology*, Jan., 1931, *16*, 52–58.

The histology of the normal thyroid of the dog was not materially changed by a roentgen dosage known to be of clinical value in some cases of hyperthyroidism. The tendency of the effect was in the direction of hyperplasia. The capsule of the thyroid was thickened only by overdosage which resulted in a skin ulcer.

The treatment used caused a definite hyperplasia of the parathyroids. In those dogs in which several months had elapsed after cessation of the treatment an increase in connective tissue of the parathyroids occurred. A gradual slight decrease in blood calcium occurred in spite of the hyperplasia.

It is pointed out that these results do not necessarily apply to the hyperplastic thyroid of Graves' disease, which is a different problem. The results indicate that the clinical dosage used in the treatment of hyperthyroidism will not injure the parathyroids.—*J. D. Camp.*

DALL'ACQUA, VIRGILIO, and DE ANTONI, VITTORIO. Ricerche sperimentali sull'azione baltericida delle radiazione di diversa lunghezza d'onda. (Experimental study of the bactericidal action of radiation of different wave lengths.) *Radiol. med.*, July, 1931, *18*, 869–887.

The question of the radiosensitiveness of bacteria is not yet definitely settled. The authors studied it experimentally by subjecting a number of kinds of bacteria to irradiation, taking care to exclude all possible sources of secondary irradiation except of course that diffused from the culture medium itself.

The different reports are probably due to sources of error in the experiments and the authors tried to exclude these by using small amounts of bacteria and counting the colonies originating from them each time. In this way even a slight bactericidal action could be detected.

They tried to establish curves of radiosensitiveness for the different kinds of bacteria by giving the cultures progressively increasing doses of radiation and comparing the bactericidal action of equal amounts of radiation measured ionometrically and produced by different potentials (100–120–140 kv.). They experimented on bouillon cultures and cultures of the same bacteria on agar.

They found that under these experimental conditions the vitality of some bacteria is injured by roentgen rays. Among these are *Bacillus prodigiosus*, the cholera bacillus, the colon bacillus, the Shiga-Kruse bacillus, the *Bacillus pyocyaneus*, the streptococcus and the staphylococcus. The radiosensitiveness of these forms of bacteria decreases in the order in

which they are named. Some of them including the *Bacillus prodigiosus*, the cholera bacillus, the Shiga-Kruse bacillus, the colon bacillus and *Bacillus pyocyaneus* are injured by relatively slight amounts of irradiation, while others, including the staphylococcus and streptoccus, require larger doses. The percentage of the colonies injured by roentgen rays increases as the dosage of radiation is increased. For amounts that are ionometrically equal, using Solomon's ionometer the sensitiveness of the bacteria varies, depending on the wave length of the rays, increasing as the wave length increases. These variations are probably not due to a selective action of the radiation, which has not yet been definitely proved, but to the amount of the incident radiation absorbed by the culture medium, which varies considerably depending on wave length. The percentage of colonies damaged was about the same in the broth and agar cultures.

The roentgen rays may have exercised their action on the bacteria either directly or indirectly by means of the secondary radiation from the culture medium but not by chemical and physico-chemical changes in the medium making it unadapted for the growth of the bacteria.—*Audrey G. Morgan.*

HEEREN, J., and PANSDORF, J. Gewebsatmung nach Röntgenbestrahlung. (Tissue respiration after roentgen irradiation.) *Strahlentherapie*, 1931, *42*, 307–327.

Experiments are described in which tissue respiration of liver and kidney tissue was determined after roentgen irradiation. The technique of the experiments is described and tables given showing the details of the results. Oxygen consumption was determined immediately after and one hour after irradiation. It was found that when the tissue was suspended in Ringer's solution there was a marked increase in oxidation, both in liver and kidney tissue which lasted forty minutes. This increase was not found when the determinations were made at a later period. The increased respiration ran parallel to the size of the dosage. When horse serum was used as a suspension fluid the increased respiration was not constant.—*Audrey G. Morgan.*

GALLAVRESI, LUIGI. Le modificazioni del quadro ematologico nei pazienti sotto posti a radiumterapia intensiva. (Changes in the blood picture in patients who have been given intense radium treatment.) *Radiol. med.*, July, 1931, *18*, 926–958.

This article reports a study of the blood picture in 30 cancer patients who were given large doses of superficial radium therapy. It was found that therapeutic doses of gamma radium rays generally decrease the number of erythrocytes but sometimes increase them. The hemoglobin tends to follow the decrease of the erythrocytes but does not always do so exactly, so that there may be changes in the color index. It may rise slightly during treatment and fall later. The number of granular erythrocytes always increases even in cases in which the total erythrocyte count decreases.

There is a marked tendency to decrease of leucocytes which in a few cases is preceded by an initial rise. This results in an absolute neutropenia and lymphopenia with a relative increase of neutrophils and a very marked relative decrease of lymphocytes. The decrease in leucocytes seems to be in proportion to the amount of irradiation.

The Arneth formula is displaced decidedly to the left immediately after treatment, followed later by displacement to the right. Few young forms are seen and distinctly premature forms of leucocytes are very rare. None of the changes observed have any very marked effect on the patient's general condition.—*Audrey G. Morgan.*

SIEVERT, ROLF M. Notes on international units for roentgen and radium dosage. *Acta radiol.*, 1931, *12*, 300–304.

The author calls attention to the desirability of an addition to the "Recommendations of the International X-Ray Unit Committee" (Stockholm, 1928) to provide for an intensity unit also, which would meet the requirements of practical roentgen therapeutics better than the unit of energy. A unit of gamma radiation is proposed, suitable for both experimental and mathematical determinations of radiation intensity.

The unit may conveniently be defined as follows: The international unit for gamma radiation intensity is the intensity at a distance of 1 centimeter from a radium preparation consisting of 1 gram of radium element (pure radium sulphate) in equilibrium with its disintegration products, provided the source of radiation is surrounded on all sides by 0.5 mm. platinum exclusively, and that the dimensions of the preparation are so small that the

source of radiation can be considered punctiform. This unit is called an intensity curve and its symbol will be Ic. The thousandth part of this unit is called an intensity millicurie and its symbol is Imc. It is recommended that in medical gamma-ray dosage the intensity be stated in Imc, the time in hours and the quality in information regarding filtration. This will give the dose in Imc-hours.

For determining the dosage in radium therapy a new measuring method described by Sievert in *Acta radiol.*, 1931, *12*, 190, has recently been introduced at the Radiumhemmet in Stockholm. This has proved very convenient for determining the unit suggested above, as the small condenser chambers used may be calibrated in Imc units without difficulty. These chambers are also suitable for roentgen-ray measurements. If a standard chamber of small dimensions should be chosen for international use a spherical condenser chamber would be very convenient because it is quite independent of the measuring devices and can be exactly defined only by giving the dimensions and the material of the walls.—*Audrey G. Morgan.*

Heeren, J. Komplementare Eigenschaften des Blutserums oder "Alexinreaktion" nach Röntgenbestrahlung. (Complementary properties of the blood or "alexin reaction" after roentgen irradiation.) *Strahlentherapie*, 1931, *42*, 189–197.

The work of other authors on the effect of roentgen irradiation on the complementary action of the blood serum, or the alexin reaction, is reviewed and the author describes his own work in which the sera of 50 patients were examined after roentgen irradiation by Huntemüller's modification of the hemolysin reaction. Among 23 patients, 14 showed a decrease of the complementary properties of the blood immediately after the end of irradiation, 6 a slight rise and 3 no effect at all. So the effect is not constant. Tables are given showing the details of the results and cases are described to show that the differences were not due to differences in dosage or technique. No special relation was found between the nature of the disease and the complementary properties of the serum.—*Audrey G. Morgan.*

Taylor, Lauriston S. Recent progress in x-ray standardization. *Radiology*, Jan., 1931, *16*, 1–13.

Advances made in the measurement of roentgen-ray quantity or intensity during the last three years are reviewed. A comparison of the cylindrical and parallel-plate types of air ionization chamber indicates that the latter is better suited for accurately determining the "roentgen." The smaller guarded field parallel-plate ionization chamber is free of all the defects of both larger types of chamber. Preference is given to the null electrostatic current measuring system when covering a wide range of sensitivities and to eliminate field distortion. For routine and secondary standardization measurements the current compensation scheme, using the radium ionization chamber, is more satisfactory. A comparison of various diaphragm systems indicates the necessity of a diaphragm close to the tube to eliminate off-focus and stem radiation. For quality measurements the effective wave length method, using thin (0.25 mm.) copper absorption screens, is recommended.—*J. D. Camp.*

Erskine, Arthur W. Accuracy in roentgen dosage. *J. Am. M. Ass.*, Sept. 5, 1931, *97*, 677–678.

Accurate dosage enables the roentgenologist to avoid the dangers of over and under exposure. The patient with malignant disease is in greater danger from the latter, since he may thus have his only chance for life withheld.

Errors of about 100 per cent may be expected in calculating dosage from indirect measurements such as meters showing voltage and current, and the distance, time and filter factors. The error can be reduced to about 25 per cent by accurate checking of intensity and quality with instruments calibrated in absolute units. The roentgen is the most rational unit we have.

The instruments with a small ionization chamber are likely to be less accurate than those with larger chambers but can be used over the skin of the patient to measure the rays actually received while the larger and more precise chambers do not show the effect of back scattering and corrections must be made.

The cost of a satisfactory measuring instrument is not large and when distributed over the number of cases treated becomes almost negligible.—*E. W. Hall.*

Kamniker, Hellmut. Erfahrungen mit der Injektion von "Betastrahlern" in maligne

Tumoren. (Experience with the injection or "beta irradiators" in malignant tumors.) *Strahlentherapie*, 1931, *40*, 427–437.

It is sometimes difficult to reach tumors with Dominici tubes so efforts have been made to find a substance that could be injected that would emit beta rays. The author has been sent such a preparation from the Kaiser Wilhelm Institute in Berlin. It is a uranium X preparation with a half-value time of twenty-four days, which guarantees a long-continued action on the tumor and on cells undergoing karyokinesis. After about 100 days it no longer has any effect so there is no danger of injurious after-effects.

The author found this preparation very effective and particularly valuable in tumors inaccessible to Dominici tubes. Injections should not be made into deep tumors not immediately beneath the site of injection, as perforation of the liquefied tumor might not take place through the injection canal but into neighboring organs or the abdominal cavity. In many cases a path should be infiltrated with the needle from the site of the injection to the center of the tumor, as this path becomes necrotic and furnishes a canal for the discharge of the liquefied tumor tissue. Or the canal may be used to introduce radium tubes into the center of the tumor. Several injections should not be made into the tumor at short intervals as that may cause an undesirably strong action. No bad by-effects on the kidneys or hematopoietic system were observed. Histological examination shows that the preparation causes necrosis. Clinically the injected tissue is liquefied in most cases but rupture does not necessarily occur. In favorable cases the liquefied tissue is absorbed and finally replaced by scar tissue.—*Audrey G. Morgan.*

WOOD, FRANCIS CARTER. Short wavelength radiation; present standards for measuring quantity and quality. *J. Am. M. Ass.*, May 23, 1931, *96*, 1753–1757.

The quantity of radiation used in roentgenography is usually so small as to be negligible, but precautions should nevertheless be taken to ascertain whether the patient has had previous exposures to roentgen rays or strong irritants.

Measurement of supersoft radiation is usually done by experimental erythemas though pastilles or ionization chambers may be used.

Medium voltage radiation may be estimated by formula provided meters are calibrated and all factors accurately considered, an entirely different set of formulas being required for different filters. Pastilles are widely used and are satisfactory for dermatologic practice.

For short wave or high voltage therapy the ionization chamber is the usual method of measurement and the best unit for measurement is the standard "r" or "roentgen" adopted by the International Congress of Radiology. Many forms of dosimeter using the ionization principle are available. Charts showing depth doses are very essential in estimating the effective radiation delivered to a tissue at a given depth.

Tables for measurement of radiation in radium therapy are given in all standard texts. —*E. W. Hall.*

SCHAAL, G., GRUSCHETZKAJA, M. A., and ZWILICHOWSKAJA, E. J. Beitrag zur biologischen Wirkung der Röntgenstrahlen. (Wirkung der Röntgenstrahlen auf die Elektrolyte Kalium and Kalzium im Blutserum des Menschen). (A contribution to the study of the biological effect of roentgen rays. The effect of roentgen rays upon the electrolytes, potassium and calcium, in the blood serum of the human body.) *Strahlentherapie*, 1931, *40*, 111–124.

After a detailed discussion of the observations pointing to the possibility of the existence of a stimulating effect of the roentgen rays, the authors describe their studies on the influence of roentgen rays upon the K/Ca ratio of the human blood serum. For radiation with roentgen rays of 180 kv., 4 ma., 0.5 mm. Zn and 1 mm. Al filter in doses of 1/6–1 full erythema dose for various groups-the authors found a shifting of the K/Ca ratio. The direction of this shift seems to depend upon the time interval between irradiation and examination of the blood. During the first day after irradiation there is a surplus of potassium, and later on, of calcium. Many clinical observations after irradiation, such as "roentgen sickness," early reaction, fluctuation in the leucocyte count, analgesic effects, etc., may be explained by the shift in the K/Ca quotient of the blood serum.—*Otto Glasser.*

GFRÖRER, O., and BERGER, HEINZ. Über die Bestimmung der Halbwertschicht bei Grenzstrahlen. (The determination of the half-value layer for Grenz rays.) *Strahlentherapie*, 1931, *40*, 590–598.

In Grenz-ray therapy it is necessary to determine the radiation quality as well as the quantity. Indirect methods of quality measurements, as for instance, reading the kilovoltage from a switchboard meter, are inaccurate on older Grenz-ray machines. Modern Grenz-ray apparatus and tubes are pretty well standardized, and the radiation output is satisfactorily constant. It is, however, necessary to calibrate each apparatus, a task which should be done by the manufacturer of the Grenz-ray transformer and tubes. As long as this is not done, the quality and quantity must be determined in each special case, and the author presents a method of measuring the half-value layer in aluminum. This consists chiefly of an aluminum foil about 1/100 of a millimeter thick, which is brought into the path of the rays. By turning the foil in the radiation beam, the rays have to pass through a varying layer of aluminum, the exact thickness of which depends upon the angle between the foil and the beam of rays. A series of measurements with this quality indicator on old and new tubes is presented.—*Otto Glasser.*

WILLIAMS, J. B., and BUDD, S. W. Oral appliance for radium treatment. *J. Am. M. Ass.*, Nov. 8, 1930, *95*, 1424–1425.

The small amount of tissue which covers the alveolar ridge makes implantation of radium unwise or impossible. Applicators of the usual type are hard to retain in position. A gum wax base dental appliance is described and illustrated. It is so constructed as to hold the radium in place for several hours without much discomfort to the patient.—*E. W. Hall.*

TARTAGLI, DINO. La proiezione di profilo obliquo anteroposteriore per l'esame radiologico laterale di un solo polmone. (Oblique anteroposterior profile projection in the roentgen examination of one lung.) *Radiol. med.*, Dec., 1930, *17*, 1388–1395.

This projection, the details of which have been described in *Riv. di radiol. e fisica med.* no. 4, 1930, avoids the superposition of images, reducing even the projected shadow of the heart so that it is seen only in profile, but showing the retrocardiac space and a complete latero-lateral view of the lung. There is a certain amount of superposition of the two mediastinal portions and of a small part of the lung of the opposite side, but not enough to interfere with interpreting the picture. Seven cases are described and roentgenograms given illustrating the projection and the results obtained by it. It is of special value in studying the interlobar fissure, the conformation of the diaphragm and the localization of adhesions in the course of therapeutic pneumothorax.—*Audrey G. Morgan.*

LUDIN, M., and WERTHEMANN, A. Lungenveränderungen nach experimenteller Röntgenbestrahlung. (Changes in the lungs after experimental roentgen irradiation.) *Strahlentherapie*, 1930, *38*, 684–701.

Experiments on rabbits are described and photomicrographs given showing the histological changes in the lungs after roentgen irradiation. In all the animals that died spontaneously there was a bronchopneumonia that was at first circumscribed and then confluent with very severe suppurative bronchitis. The epithelial cells of the alveoli are destroyed after passing through various stages of degeneration, particularly swelling and honeycomb-like or vacuolar degeneration of the protoplasm and destruction of the nuclei. Around the bronchopneumonic foci there is severe edema of the lung with desquamative catarrh. In the bronchial epithelial cells there are also extensive signs of proliferation including: (*a*) increase in height and stratification with regenerative proliferation inside the alveoli; (*b*) autonomous growth of the epithelial cells with formation of pictures resembling carcinoma, for example, atypical mitoses, polymorphism of the cells and pycnoses and destruction of nuclei.—*Audrey G. Morgan.*

WERTHEMANN, A. Experimentelle Röntgenschädigungen des Herzmuskels. (Experimental roentgen injury of the heart muscle.) *Strahlentherapie*, 1930, *38*, 702–709.

Experiments were performed on rabbits. In the first series of experiments 5 adult rabbits of the same size were irradiated once a week alternately on the thorax and back. The fields were 5×5 cm., the focus-skin distance 23 cm., filter 8 mm. aluminum; 2.3 ma., 160 kv., 0.55 mm. copper half-value layer. The animals were given 500 r at a treatment until they died. They bore from 17 to 43 treatments and lived from 131 to 343 days. In the second series the experiments were the same except that the fields were 12×12 cm. The animals died after 10 to 15 treatments; the average life was 97.5 days. The heart findings are described and

illustrated by photomicrographs. The heart injuries were: (*a*) Injuries of the parenchyma: (1) simple cloudy swelling with loss of transverse striation; (2) finely granular to coarse or sometimes waxy degeneration with the fibrillary striation destroyed in places and preserved in places; (3) atrophy of muscle fibers extending to complete destruction; the fibers at first became tortuous and finally only empty sarcolemma tubes remained; (4) simple destruction of nuclei with very few nuclei in the degenerated parts. (*b*) Changes in the interstitial connective tissue: (1) perivascular and extensive diffuse inflammatory infiltration; (2) miliary induration leading to distinct sclerosis.—*Audrey G. Morgan.*

KAHN, HERBERT. Die Ablagerung von aktivem Wismut in malignen Tumoren. (The deposition of active bismuth in malignant tumors.) *Strahlentherapie*, 1930, *37*, 751–766.

The author's experiments are based on the idea that it may be possible to store substances in cancer cells electively that will injure them without injuring the normal tissue cells. He first experimented with mice, giving injections of inactive bismuth and later with bismuth activated with radium E. He found that the bismuth was at first distributed quite uniformly in the tumor tissue and normal tissue but that the body cells gave it off very quickly while the tumor cells retained it. Forty-two hours after the injection there was 18 times as much bismuth in the tumor as in a corresponding amount of normal tissue.

He is not yet ready to report therapeutic results of the method. There are many questions still to be settled, such as optimum dosage, the nature and time sequence of the injections and whether this treatment can be combined with external radium or roentgen treatment and if so in what way. His chief object in this article is to rouse interest in the possibilities of the method.—*Audrey G. Morgan.*

POHLE, ERNST A., and BUNTING, C. H. Skin reactions following exposure to roentgen rays. II. A study of the effect of graded doses of two different wave lengths on the skin of rats. *Radiology*, Dec., 1930, *15*, 647–659.

The skin of 80 rats was exposed to two types of unfiltered roentgen rays produced at 7 kv. and 60 kv., respectively. The dose amounted to 500 r, 750 r, 1,000 r, 1,250 r, 1,500 r, 2,000 r, and 2,400 r.

The reactions were studied macroscopically and microscopically. It appeared that the changes observed in the skin following exposure to both qualities of roentgen rays in equal doses were very similar.

Although it is not advisable to transfer directly the results of animal experiments to human pathology, the conclusion seems justified that roentgen rays of from 1 to 2 Ångströms should be used therapeutically as other roentgen rays. Clinical observations support this conclusion.—*J. D. Camp.*

FRONTALE, GINO. Via inalatoria o via transcutanea? (Should irradiation be given by inhalation or through the skin?) *Radiol. med.*, Nov., 1930, *17*, 1316–1333.

Experiments were made on young white rats which were given McCollum's rachitic diet No. 3143. Some of them were given inhalations of irradiated air, others were given direct irradiation of the skin without any inhalation of irradiated air and others were not given any treatment at all. The animals given inhalations of irradiated air, either as a preventive treatment in the beginning of the experiment or as curative treatment after the beginning of signs of rickets developed serious rickets, shown during life by roentgen examination and after death by histological examination. These symptoms of rickets did not differ in any way from those in the animals that were not given any treatment at all. On the contrary, the rats given direct irradiation on the skin and no inhalation of irradiated air did not show any signs of rickets when the irradiation was given in the beginning of the experiments and were cured when the irradiation was not given until after signs of rickets had begun. In these cases ossification was shown to be normal by roentgen examination during life and histological examination after the animals were killed.—*Audrey G. Morgan.*

UHLMANN, ERICH. Über die Möglichkeit der Vermeidung von Strahlenschäden der Haut. (The possibility of preventing radiation damage to the skin.) *Strahlentherapie*, 1930, *38*, 103–112.

Doses of 110 per cent of a skin unit dose (150 kv., 1.5 mm. half-value layer in Al) were applied to the ears of rabbits. Epilation and skin reactions were carefully observed. In order to study the properties of the Raderma salve as a prophylactic for undesired skin reactions in

radiation therapy, as suggested by Wintz, one ear of each animal was treated with this salve. The areas thus treated did not show any skin reaction, and practically no epilation. A histological examination of these areas did not show any damage to the tissue as compared to the areas not treated with the salve. A study of the influence of the various components of the Raderma salve was made with skin reactions produced with ultraviolet light. All of the components, with the exception of vaseline, have a retarding effect upon the skin reaction.—*Otto Glasser.*

Cappelli, Luigi. Sieroanafilassi e raggi. (Serum anaphylaxis and rays.) *Radiol. med.*, Nov., 1930, *17*, 1308–1316.

The action of irradiation in serum anaphylaxis was studied experimentally in rabbits and the effectiveness of irradiation in decreasing anaphylactic shock and crisis, which has been described by other authors, was confirmed. Irradiation is more effective when it is given immediately after the serum injection instead of preceding it. The physiochemical conditions which cause precipitation become more marked in animal serum parallel with the progress of serum sensitization. Spontaneous precipitation in normal serums or acquired precipitation in sensitized serums is inhibited or even prevented by irradiation. Irradiation is effective in preventing flocculation even in vitro in normal or sensitized animal serums.

From these experimental results the author concludes that irradiation decreases anaphylaxis because of the changes which it brings about in colloidal instability. This is a purely physiochemical phenomenon; that is to say, it is not due to the vital activity of the cells as it is seen in serums irradiated in vitro. The author thinks that if it were possible to determine the physiochemical conditions which bring about anaphylactic flocculation it would show the physiochemical changes caused directly by irradiation in the organic colloids.—*Audrey G. Morgan.*

Cappelli, Luigi. Anafilassi e raggi. Riserva alcalina. (Anaphylaxis and rays. Alkali reserve.) *Radiol. med.*, Dec., 1930, *17*, 1361–1369.)

The theory of acidosis is accepted in biochemistry as explaining the anaphylactic charge and as the first cause of radiobiological phenomena. In order to determine whether this is correct or not the author made experimental studies on rabbits in which he observed pH and alkali reserve during preparation for anaphylaxis and during and after irradiation with roentgen rays and radium. No real or compensated acidosis was found in these experiments either in serum or peptone anaphylaxis or in irradiation. On the contrary, when the serums were irradiated in vitro they showed a change in the direction of alkalosis. There is no denaturization of body proteins by rays, at least not in therapeutic doses and irradiation has not any capacity for intensifying biological activity in the animal with an anaphylactic charge.—*Audrey G. Morgan.*

Cappelli, Luigi. "Radioproteinemia" and "radioanafilassi" nei cancerosi sottoposti a trattamento radioterapico. (Radioproteinemia and radioanaphylaxis in cancer patients who have been given radiotherapy.) *Radiol. med.*, Oct., 1930, *17*, 1150–1156.

The author describes immunological and biochemical investigations made on cancer patients who had been given radium therapy successfully. He comes to the conclusion that the protein elements of the tumor which are absorbed after radium treatment are split by the action of the proteolytic enzymes into aminoacids and their derivatives; in this form they pass into the blood and are excreted by the excretory organs. The absorption of the tumor proteins therefore is not followed by any radioproteinemia or any allergic condition (radioanaphylaxis). There is no reason for the use of these terms therefore, for the human organism always has enough enzymes available to prevent toxic derivatives entering the blood as a result of the breaking down of tumor tissue.—*Audrey G. Morgan.*

Kahlstorf, A. Untersuchungen über die Hauttoleranz bei protrahiertfraktionierter Röntgenbestrahlung. (Investigations of the skin tolerance for protracted, fractional roentgen therapy.) *Strahlentherapie*, 1930, *38*, 499–520.

After a short discussion of the work done by Regaud and Ferroux, Schinz, Miescher and others, in applying roentgen rays in fractional and protracted doses, the author describes his own experiments on the study of the skin tolerance of rabbits. A protracted, fractional dose corresponding to 4 epilation doses did not produce an epilation fourteen to twenty weeks

after the final treatment (radiation technique: 168 kv.; 1.3 mm. Cu and 1 mm. Al filter; 3 ma.; 1.1 mm. Cu half-value layer; 4,200 r total dose in one sitting; 14×300 r within 120 minutes with a 24-hour interval for protracted, fractional treatment). The author concludes from these results that by applying subdivided doses, the skin tolerance is increased considerably. In a series of histological experiments on the human skin, which was irradiated with protracted, fractional doses equivalent to 5 or 6 skin unit doses, it could be shown that only minor cell degenerations occurred. This proves again Miescher's results, who showed that the subdivision of the applied doses is primarily responsible for the increased skin tolerance. A protracted, fractional method of treatment, as suggested by Regaud and Coutard, is the method of choice in all cases in which there is only a small difference in the sensitivity of the cells of the neoplasm and the normal tissue.—*Otto Glasser.*

JUUL, JENS. Einmalige Höchstdosis, fraktionierte Bestrahlung oder Sättigungsmethode? Untersuchungen an Karzinommäusen. (Single massive dose, fractional dose or saturation method? Experiments with cancer mice.) *Strahlentherapie*, 1930, *38*, 623–640.

Mice with implanted cancer were irradiated with roentgen rays (220 kv.; 2.8 ma.; 5 mm. Al filter; 23 cm. focal skin distance) and radium (200 mc-hr.; 1 mm. lead and 0.6 mm. Al filter). The malignant tumors showed an incomplete cumulation of fractional roentgen doses. Continuous radium irradiation of varying intensity led to a time factor which is smaller than 1. The accumulation of a tumor and of normal skin is quite different. A more favorable ratio between the effect upon the tumor and the effect upon the skin is obtained by fractional treatment than by massive treatment, that is, an increase in the selective effect of the rays is obtained. Distribution of the treatment according to the saturation method led to a more favorable effect than fractional irradiation. The results obtained, however, cannot be transferred directly to conditions of the human being.—*Otto Glasser.*

RATTI, ARDUINO. La ripartizione dell'energia nella Roentgenterapia profonda. (The distribution of energy in deep roentgen therapy.) *Radiol. med.*, Nov., 1930, *17*, 1213–1250.

What is known of the distribution of radiant energy in the deep tissues is based almost entirely on measurements made on phantoms. It remains to be determined whether these findings hold good in practical roentgen therapy and if so how exact they are.

Ratti reviews the methods of studying this question and calls attention to the sources of error in using small ionization chambers. He reviews the literature and describes the results that he himself has obtained in a series of investigations using five different ionometers with small chambers. He tried particularly to find out whether the lack of homogeneity in the structure of the human body caused any considerable variation in the value of deep doses. He studied particularly the reaction of the bones and the air-containing cavities to irradiation. From a critical analysis of the results he concludes that, in a general way, the variations found are not great enough to affect the practical value of the table of deep doses prepared from measurements made on the phantom.—*Audrey G. Morgan.*

DORNEICH, M. Über die Frage der Verteilung der Röntgenstrahlenintensität im Körper bei Tiefentherapiebestrahlungen. (The problem of the distribution of roentgen-ray intensity within the body in deep therapy.) *Strahlentherapie*, 1930, *38*, 591–622.

The author, who has worked for a number of years in Dessauer's institute on the problem of the intensity distribution of roentgen rays within the body, or within a phantom, presents in the first section of his paper a comprehensive discussion of the measurements of intensity distribution made previously, and of the fundamental aspect of the problem. The photographic and ionization methods of intensity measurement are discussed in detail. Special attention is called to the various errors which are usually made in measurements with small ionization chambers, such as disregarding the effect of the length of the inner electrode, of the position of the chamber within the phantom, of the shadow and absorption effects of the chamber holder, of the direction effect within a small chamber, etc. In a second paper, to be published, the author's results of the measurements of depth intensities will be communicated.—*Otto Glasser.*

VALLEBONA, A., and CAPOCACCIA, M. Ulteriori osservazioni sull'azione dei raggi X sui tes-

suti di origine mesenchimale. (Further observations on the action of roentgen rays on tissues of mesenchymal origin.) *Radiol. med.*, Oct., 1930, *17*, 1188–1192.

The authors have previously published a series of experiments on the action of roentgen rays on tissue of mesenchymal origin, particularly hematopoietic tissue. The experiments reported in this article were made with the object of determining whether the lesions that they found in the blood and hematopoietic organs were due to direct action of the rays or if they were caused by toxins produced by the lesions of all the tissues brought about by the application of rays to the whole body of the animal. For this purpose they made a series of experiments irradiating only the hind leg, while the rest of the body was protected from the rays. The total dose given was 1200 units R.T.

Some of the animals had been previously colored by means of 4 intravenous injections of 1 per cent trypan blue. Histological examination of some of the animals killed a week after the irradiation and some killed two weeks after showed that in the irradiated bone marrow there was a decrease of the number of polymorphonuclear leucocytes, particularly the neutrophils, and a slight reduction in the number of myelocytes. The basophils, eosinophils, hemocytoblasts, hemohistioblasts and erythroblasts were entirely normal. From these and their previous experiments, the authors conclude that the lesions of the hematopoietic organs caused by roentgen rays are more serious, the greater the extent of the surface irradiated. But even under the experimental conditions described in this article the cells most sensitive to the action of the rays were the polymorphonuclear neutrophil leucocytes.—*Audrey G. Morgan.*

Laser, Hans. Strahlenbiologische Untersuchungen an Gewebkulturen. (Biological effects of irradiation of tissue cultures.) *Strahlentherapie*, 1930, *38*, 391–437.

The method of tissue cultivation has proved very useful in testing the sensitiveness of normal and malignant cells to irradiation. Sensitiveness is shown by inhibition of growth. Sensitiveness and latency stand in a certain definite relation to rapidity of proliferation. This is true of malignant cells as well as of normal ones. Cultures, the rapidity of whose growth has been decreased experimentally to a latent stage, show no change in their ordinary course of growth on slight irradiation. After irradiations that do not cause death there is gradual recovery. There is sometimes, but not as a rule, a temporary compensatory increase of growth of the irradiated cultures as compared with controls. By preliminary irradiation followed by repeated transplantations increased sensitiveness could be attained as a result of the increased regeneration. Repeated irradiation at a certain time of a culture that has been given preliminary irradiation does not cause a further inhibition of growth (immunity). The biological sensitiveness measured by inhibition of growth is equal to the product of the time and intensity. Carcinoma cultures show particularly great sensitiveness on preliminary irradiations followed by transplantations. This behavior, caused by special lability, is considered a quantitative not a qualitative difference from normal cells.—*Audrey G. Morgan.*

Schaefer, W., and Witte, E. Beiträge zur Klärung der biologischen Wirkungen von modernen Kathodenstrahlröhren. (A contribution to the clarification of biological effects obtained with modern cathode-ray tubes.) *Strahlentherapie*, 1930, *38*, 767–774.

After a discussion of fundamental data on electrons, and an explanation of the heat effects of cathode rays, the author discusses the difference in biologic effects to be expected from cathode and roentgen rays. In order to arrive at a fair comparison of the results produced, it is necessary to increase the roentgen-ray doses considerably. In some experiments carried out with about 3,000,000 r of both roentgen and cathode rays, it could be shown that the biological effects produced were practically identical.—*Otto Glasser.*

Vierheller, Friedrich, und Saralegui, J. A. Röntgenwellenlänge und biologischer Effekt. (Wave length of roentgen rays and the biological effect.) *Strahlentherapie*, 1930, *38*, 641–654.

The authors investigated the problem of the dependence of biological effect upon wave length. The work of Glasser and Behnken on this question is discussed in detail, together with previous investigations of the authors. Further physical and biological experiments with germinating beans have shown that the wave lengths of the secondary rays are much longer than those of the primary radiation, and

that the secondary wave lengths of the primary radiation commonly used in therapy are very nearly the same. A difference in the biological effect is therefore not to be expected. Based upon the absorption law and upon the theory that a certain number of electrons is released in a given volume through the absorption of the radiation energy one, the r numbers for various primary radiation qualities can be calculated. The values thus obtained agree well with those of Glasser previously published. For the radiation qualities generally used no difference in the biological effect of the radiation on germinating beans could be found.—*Otto Glasser.*

ELLINGER, and GRUHN, E. Über biologische Röntgenstrahlenwirkung. IV. Mitteilung. Über die Verstärkung der Röntgenstrahlenwirkung durch Sekundärstrahlung. (Biological effects of roentgen rays. IV. The increase of roentgen-ray effects through secondary radiation.) *Strahlentherapie*, 1930, *38*, 58–97.

The authors investigated the effects of a large series of secondary radiators upon the photographic plate and upon cultures of *Bacterium prodigiosus*. The elements used as secondary radiators were Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, Pd, Ag, Cd, Sn, Sb, Te, Ce, Ta, W, Pt, Au, Hg, Tl, Pb, Pi, Th, and U. These substances were chemically pure and were in small foils or blocks of at least 0.8 mm. thickness and an area of 10×20 mm. The surface was highly polished, and they were cemented into an aluminum box in such a fashion that their surfaces were all in one plane. In the photographic experiments this surface was at a distance of 1 mm. from the photographic plate. The plate and box were wrapped in black paper and placed in a cardboard box. The roentgen rays had to go through the box and the glass of the plate before reaching the secondary radiators. The following radiation conditions were used in most of the experiments:

(1) 225 kv., 4 ma., 0.2 mm. gold plus 1 mm. silver plus 0.5 mm. Zn, 500 mm. distance, 1 r in 1 minute and 10 seconds.

(2) 160 kv., 4 ma., 3 mm. Zn., 500 mm. distance, 1 r in 1 minute and 14 seconds.

(3) 100 kv., 4 ma., 1 mm. Zn, 500 mm. distance, 1 r in 2 minutes and 38 seconds.

(4) 50 kv., 4 ma., 3 mm. Al, 500 mm. distance, 1 r in 1 minute and 7 seconds.

In some of the experiments thin aluminum foils of 7, 14 and 21μ were placed between the secondary radiator and the emulsion.

The results of these experiments showed that the additional darkening on the plate caused by the secondary radiation depends: (1) upon the wave length of the primary radiation, that is, the relative effect of the secondary radiation increases with increasing hardness of the primary radiation; (2) upon the atomic number of the secondary radiator, that is, it increases with increasing atomic number. This increase, however, is not linear, but maxima appear, which shift with decreasing wave length towards the elements with lower atomic number. The experiments with aluminum filters proved that the effects of the secondary radiation upon the photographic plate are caused by secondary rays of rather high penetration, probably by the fluorescent rays of the various elements.

The experiments with prodigiosus cultures were carried on in a similar way. The cultures were obtained in a way similar to that proposed by Holthusen. A suspension was sprayed on an agar Petri dish from a distance of 50 cm. for 4–6 seconds, during which time the Petri dish was revolving slowly. These cultures were then irradiated similarly to the photographic plate. They were then photographed; a special grid arrangement permitted showing on the photograph the relative position of the various secondary radiators. The number of colonies for each field was then counted under a microscope. The addition of the secondary rays to the primary rays changes completely the effect upon the cultures. Primary roentgen rays of various wave lengths began to have an effect upon the cultures at a dose of about 500 r. A certain percentage of the cultures, however, survived doses as high as 15,000 r. If secondary rays of elements of a high atomic number are added to the primary rays, a small primary dose of only 300 r leads to complete sterilization. Pure primary radiation of medium hardness (100 kv.) has a maximum effect upon the bacteria. If the secondary rays are added, the lethal effect for a constant dose of the primary radiation increases with increasing wave length of the primary radiation. The bactericidal effect of the secondary radiation increases with increasing atomic number of the secondary radiator, showing characteristic maximum and minimum, which depend upon the wave length of the primary radiation. The effective rays have a very small penetrative power. They are

absorbed completely by 4–5 mm. of air. It is therefore concluded that the bactericidal effect of roentgen rays depends primarily upon the absorption of photo-electrons.—*Otto Glasser.*

Podkaminsky, N. A. Über die sensibilisierende Wirkung des Hämatoporphyrins gegenüber den Röntgenstrahlen. (On the sensitizing effect of hematoporphyrin for roentgen rays.) *Strahlentherapie*, 1930, *38*, 98–102.

After a discussion of the various experiments of Hausmann, Meyer-Betz, and others, on the sensitizing effect of hematoporphyrin under the influence of light, the author investigates the possibility of such an effect for roentgen rays. One cubic centimeter of hematoporphyrin solution was injected into white mice, which were subsequently irradiated, in the dark, with roentgen rays. The animals were left in the dark. The author found that typical subacute and chronic forms of "roentgen-ray sickness" could be observed, similar to those of the "light sickness" observed by others. This sensitizing effect may possibly be made use of in the roentgen treatment of superficial and deeper situated organs.—*Otto Glasser.*

Taylor, Lauriston S., and Singer, George. An improved form of standard ionization chamber. *Radiology*, Dec., 1930, *15*, 637–646.

A modification of the open-air parallel plate ionization chamber, readily portable and adapted to field use, is described. In this chamber, narrow guard plates are supplemented by a system of ten guard wires across the ends of the chamber. The wires are so spaced that roentgen-ray scattering from them is negligible. By this means a uniform electrostatic field between electrodes is obtained without the use of wide guard plates and the large plate-to-shield spacing necessary in the primary standard. This design has permitted a decrease in the volume and weight of the secondary standard by a factor of 15.

The results of direct comparisons between this chamber and the primary standard are given and indicate that the "roentgen" can be reproduced by the former with the same accuracy as the primary standard. The problem of diaphragming is identical for the two chambers, and for a given tube the same inverse power law holds for both. Like the standard chamber, the new chamber does not require that corrections be made for differences in roentgen-ray quality.

Any of the usual electrostatic measuring systems may be used with this chamber, although for precise work a null or current compensation system is desirable.

It is expected that this type of chamber will be found useful in the international comparisons of the "roentgen" now pending, for which purpose the "fingerkutkammer" is generally inadequate.—*J. D. Camp.*

Hase, Hermann, and Küstner, Hans. Stielstrahlung, Luftschwächung und quadratisches Abstandsgesetz. (Stem radiation, air absorption and the square law of distance.) *Strahlentherapie*, 1930, *38*, 543–556.

Since it has been stated again and again that the inverse square law does not hold for roentgen rays, the authors investigated the sources of error which are inherent in the measurements of the distance law, since this law must hold for roentgen rays as well as for light rays. By means of an exact measuring arrangement, using two roentgen tubes with different types of targets, and properly selected series of diaphragms, and two Küstner "Eichstandgeräte," the authors find that disregarding the stem radiation and the air absorption may lead to serious errors in checking the inverse square law of distance. If correction for air absorption is made, and if the diaphragms are selected in such a way as to permit the total stem radiation to enter the measuring apparatus, the inverse square law of distance was found to hold exactly.—*Otto Glasser.*

Hoede, Karl. Beitrag zur Dosierung mit der Sabouraud-Noiré-Tablette. (Dosage with Sabouraud-Noiré tablets.) *Strahlentherapie*, 1930, *38*, 173–176.

Dosage in skin therapy is still widely measured with Sabouraud-Noiré tablets. On account of this general use, an exact knowledge of the possible errors in this measuring procedure is necessary. The author made a series of measurements with radiation qualities corresponding to half-value layers of 0.32–4.28 mm. of Al in order to determine the effect of the absorption in the tablet, as well as in its holder, upon the measured dose when the tablet is placed part of the treatment time in the path of the rays. The absorption measurements were made with a Hammer dosimeter. It was found that the absorption in the tablet itself is rather small, but that the tablet holder absorbs the rays considerably. This is especially

important when small areas are treated. Errors in the determination of the intensity, especially in the center of the area, amount to as much as 50 per cent. The error varies according to the quality of the radiation used. A correction for these errors must be made in practical dosimetry with the Sabouraud-Noiré tablets.—*Otto Glasser.*

NEEFF, TH. C. Zur Standardisierung der Röntgendosiseinheit in der Praxis. (The standardization of the roentgen dose in practice.) *Strahlentherapie*, 1930, *38*, 177–183.

In comparing the r of his secondary standard Wulf ionometer, which was calibrated by Behnken in the Phys.-Techn. Reichsanstalt in Berlin, with a small Küstner "Eichstandgerät," and with another calibrated Wulf ionometer used by Glocker, the author finds a number of discrepancies in the units as laid down experimentally in these various instruments. Since the accuracy of his measuring technique in obtaining these results was questioned by Behnken and Jaeger, the author gives close attention to the importance of the measuring arrangement with which the transfer of the unit from the primary to the secondary standard is accomplished, and also gives a detailed description of his set-up.—*Otto Glasser.*

ALBRECHT, E. Die Eicheinrichtung des Radiologischen Instituts der Universität Freiburg i. Br. (A standardization station of the Radiological Institute of the University of Freiburg i. Br. Absolute determination of the r.) *Strahlentherapie*, 1930, *38*, 789–790.

A large air ionization chamber constructed at the Freiburg Radiological Institute to determine the r is described in detail. A series of diaphragms, including one close to the tube, is used. The ionization current is measured with an Edelmann electrometer in compensation circuit. The accuracy of the intensity measurements is less than 1 per cent. The accuracy of the comparative measurements with a thimble ionization chamber is about 2–3 per cent, due to the geometrical difficulties in placing the chambers in the path of radiation. A principal difference exists between the air chamber with all its diaphragms, and the small ionization chamber, which receives radiations from all directions. Further work must be done to arrive at a standard set-up for measuring small ionization chambers by means of the large air chamber.—*Otto Glasser.*

KRASSO, ILOMA. Anwendung und Dosierung von Buckys Grenzstrahlen in der Augenheilkunde. (The use and dosage of Bucky's Grenz rays in ophthalmology.) *Strahlentherapie*, 1930, *38*, 358–360.

Grenz rays lend themselves well to the treatment of various diseases of the eye on account of their softness. Preliminary experiments on rabbits' eyes have shown that no damage to the lens of the eye was observed after the application of an erythema dose. Doses of 4,000 r of Grenz rays of a half-value layer of 0.025 mm. Al produced necrotic processes of the epithelium, which, however, quickly cleared up. In 200 cases of diseases of the human eye 50–200 r were applied, the smaller doses in acute processes, and the higher doses in chronic conditions. Doses were measured with a Strauss' Mecapion. A list of 14 diseases of the eye which were beneficially influenced by Grenz rays is given. Late reactions have not been observed after a period of fifteen months after treatment.—*Otto Glasser.*

MEYER, HEINZ-THEODOR. Über Härtung von Grenzstrahlen durch Luft. (The hardening of Grenz rays by air.) *Strahlentherapie*, 1930, *38*, 778–784

The author made absorption measurements in aluminum with an integral dosimeter on a Phoenix Grenz-ray tube with tungsten anticathode. He found that for Grenz-ray tubes with Lindemann windows, the hardening effect of the rays with increasing focal skin distance is greater for high voltages than for low ones. The radiation quality, as well as quantity, must be determined separately for each Grenz-ray tube in their dependence upon tension and focal distance. Sputtering from the tungsten target changes the transparency of the Lindemann window and re-calibration of the tube is necessary after each one hundred hours. The results found by the author are in good agreement with those of Glasser and Beasley.—*Otto Glasser.*

BÖHM, ALEXANDER. Die Anwendung und Indikationen der weichen Röntgenstrahlen. (The indications for soft roentgen rays and methods for their application.) *Strahlentherapie*, 1930, *38*, 341–352.

The author discusses the method of production of soft roentgen rays, or Grenz rays. In order to overcome the difficulties of irradiating large skin areas properly with the Grenz rays,

he suggests a system of successive application which permits covering a large area of the skin without overlapping. The intensity distribution within the irradiated area is given for various combinations. The dose was measured with the skin reaction, as well as with a dosimeter in "roentgens." A number of diseases which were beneficially influenced by the Grenz rays is given, with the therapeutic doses in r. Late reactions were not observed.—*Otto Glasser.*

Böhmer, Lothar. Über eine Fehlerquelle bei der Grenzstrahlmessung an der Müller-Weichstrahlröhre. (A source of error in measuring Grenz rays produced with a Müller soft ray tube.) *Strahlentherapie*, 1930, *38*, 353–357.

Limiting the Grenz-ray beam of a Müller Grenz-ray tube by means of various diaphragms leads to variations in the intensity within the central beam. An explanation of the effect of a diaphragm upon the beam coming from a ring-shaped focal spot is given, together with the intensity data as determined by means of a small Küstner "Eichstandgerät," equipped with a Grenz-ray chamber.—*Otto Glasser.*

Neeff, Th. C. Zur Röntgendosierung in der Praxis. (Dosage in practical roentgen therapy.) *Strahlentherapie*, 1930, *38*, 322–328.

In order to show to what extent the experimental determinations of the international dosage unit for roentgen rays, the r, as laid down in various standardization institutions, agree, the author compared these values of the unit by means of a small Küstner "Eichstandgerät" in fifteen institutes in Germany, Australia, Switzerland, Belgium and France. This transportable instrument had been calibrated in the author's institute and in Küstner's institute in Göttingen, and its constancy on the trip was controlled with radium. While the average differences found between the experimentally determined units in the various standardization stations were not considerable, larger discrepancies were found in a few of the institutes which amounted to as much as 18 per cent. While these results are not of great importance for practical roentgen therapy, they are very significant for scientific measurements of roentgen-ray intensities, and therefore steps should be taken to obtain a better agreement. The reason for the discrepancies can probably be found in the individual measuring arrangement for determining the r, and the author supports the suggestion to specify the measuring arrangement to be used for the calibration of the secondary instruments. Suggestions for the set-up of such a measuring arrangement are made.—*Otto Glasser.*

Giebmanns, A. Wirksame Bekämpfung von Filmbränden. (Effective measures against film fires.) *Strahlentherapie*, 1930, *38*, 196–198.

The author has constructed a sprinkler arrangement which can be directly mounted in the film files. The cooling effect of the water is therefore concentrated upon a small space and the water can effectively dissolve gases which are formed by the slow burning of films. The efficiency of this small sprinkler outfit was tested by the Chem.-Techn. Reichsanstalt and found to work very satisfactorily in stopping film fires and the formation of gases.—*Otto Glasser.*

Schwarz, G. Über die theoretischen und praktischen Grundlagen einer Lang-Schwach-Bestrahlungsmethode. (On the theoretical and practical foundations of radiation therapy with small doses extended over long periods of time.) *Strahlentherapie*, 1930, *37*, 709–718.

Schwarz discusses the physical and biological effects of radiation therapy, especially the reaction produced upon the human skin in regard to the application of the dose in relation to time. From a study of the results obtained biologically by massive radiation, on the one hand, and small doses of radiation distributed over long periods of time, on the other hand, he comes to the conclusion that the Schwarzschild law also holds in radiation therapy. It is, therefore, important to indicate doses not only in r-units and effective wave lengths, but one also should add the "minute-r-number." A few examples in the literature, such as the experiments of Krönig and Friedrich and Glasser and Seitz, are cited to indicate that the results found by these authors can easily be explained by the fact that the same "minute-r-number" was not used in their respective dose measurements. Based on the observation that the tumor reaction has a lower threshold value than the surrounding tissue, and also a smaller reversibility than the skin, Schwarz proposes to use small doses of roentgen rays (0.5 ma.) over long periods of time in order to obtain the highest possible biologic effect. He believes in using small, movable therapy machines which deliver

a dose of 600 r in about four hours, which can be used directly at the bedside of the patient. A total dose of 1800 r is applied with intermissions in three days. Schwarz believes that this type of treatment is the treatment of choice for many conditions, and satisfactorily replaces teleradium therapy.— *Otto Glasser.*

GENTNER, WOLFGANG, and SCHWERIN, KURT. Über den Zeitfaktor der Strahlungsreaktion des Eiweisses. (On the time factor of the reaction of radiation upon albumin.) *Strahlentherapie*, 1930, *37*, 788–794.

Albumin was irradiated with ultraviolet light from a mercury arc lamp. The quartz tube with the albumin solution was fastened to the diaphragm of a Rajewsky universal dosimeter, which permitted the determination, photoelectrically, of the intensity at the site of the solution. The intensity could be varied over a wide range by means of a rotating sector in front of the arc lamp, or by varying the distance. The reaction of the radiation energy upon the albumin was studied by counting the albumin particles in Brownian movement. It was found that the latent period up to the beginning of an increase of the small particles, as well as the ratio of their increase, depends upon the radiation time and the radiation intensity, or, in other words, upon the "exposure." The latent period diminishes and the number of particles increases with the "exposure." The curves representing the reciprocal values of the latent period and the increase of the particles are reproducible, and therefore present an accurate measure of the reaction of radiation upon albumin. If for the same "exposure" the intensity is varied in a ratio up to 1:1400, the latent period decreases for strong intensities, that is, the "time factor" is less than one (0.904). This deviation of the Bunsen-Roscoe law proves that the obtained reaction is a secondary one, and is the result of a non-primary reaction. A comparison of the "time factor" for albumin with that of other biologic reactions, which under certain conditions is permissible, shows that Keller found the same time factor for radiation of the human skin with ultraviolet, while Seide, Liechti and Holthusen, working with ascaris eggs, arrived at a time factor of one.—*Otto Glasser.*

REISNER, ALFRED. Untersuchungen über die Veränderungen der Hauttoleranz bei verschiedener Unterteilung der Strahlendosis. (Experiments on the variations in skin tolerance after application of subdivided doses.) *Strahlentherapie*, 1930, *37*, 779–787.

After a discussion of the biological foundation of the application of massive and subdivided doses of roentgen rays in cancer therapy, the author discusses the methods of Regaud and Coutard in France, and of Kingery and Pfahler in the United States. The saturation method of Pfahler is discussed in detail, and the experiments made at the Holfelder Clinic in Frankfurt to substantiate the results obtained by Pfahler are described in detail. The physical doses were measured in r and the skin reactions were studied by means of a Schall erythema meter. The course of the erythema, which was found to occur in wave form, is demonstrated in a series of curves. They show that for small initial doses the saturation doses, according to Pfahler, are not sufficient to produce the same erythema effect as is obtained with a full initial dose. The biologic effect, consequently, is smaller. It was also found that a daily applied saturation dose has considerably less effect than a saturation dose applied every second day. Further experimental work is to be done in order to determine exactly the degree of the initial and the saturation doses. These experiments, together with the experimental study of the Regaud-Coutard method are in progress at the Holfelder Institute.—*Otto Glasser.*

NÜRNBERGER, LUDWIG. Die tierexperimentellen Gründlagen zur Frage der Spätschädigung nach Röntgenstrahlen. (The experimental foundations gained on animals on the question of late reaction of roentgen rays.) *Strahlentherapie*, 1930, *37*, 432–490.

Nürnberger, the Director of the Halle Gynecologic Clinic, presents here a detailed monograph of the present-day knowledge of late reactions in animals under the application of roentgen rays. After a critical review of the literature, which includes the work of research men in this country, especially of H. J. Muller with *Drosophila melanogaster*, the author discusses the possibility of the existence of late reactions of roentgen rays.

In studying the effect of the roentgen rays upon the ovum in animal experimentation one has to distinguish between early impregnation, that is, impregnation before roentgen-ray sterility occurs, and late impregnation, that is, impregnation after roentgen-ray sterility and the

subsequent restitution of the ovum. The fact that an early damage exists after roentgen irradiation, seems to be pretty well established and proved by animal experiments. As far as late reactions are concerned, Nürnberger comes to the conclusion that there is no experimental evidence of late reaction upon the ovum from the effect of roentgen rays. The effect of irradiation of the ovum of the drosophila, for instance, can no longer be noticed two weeks after irradiation.

Numerous explanatory drawings and references to the literature accompany this important article, which should be read in the original.—*Otto Glasser.*

Regaud, Cl., and Ferroux, R. Sur la diversité des réactions des tissus traités par les rayons X, en rapport avec le facteur temps, et sur la relativité de la dosimétrie biologique dans la roentgenthérapie des tumeurs malignes. (On the diverse reactions of the tissues treated by roentgen rays in relation to the time factor, and on the relativity of the biologic dosimetry in roentgen therapy of malignant tumors.) *Arch. Inst. du Radium de l'Univ. de Paris*, *2*, 293–318. (Also *Ztschr. f. Krebsforsch.*, 1930, *32*, 10–26.)

In 1927 and 1928, the authors published the results of their first experiments on the relation of the time factor and the effect produced by the roentgen rays on the teguments, anorectal mucosa and testicular tissues of rabbits. Convinced that the results of such research must be of capital importance in the establishment of the proper technique of irradiation in malignant tumors, further experiments were made. The following conclusions were reached:

1. The sterilization of seminal epithelium by roentgen rays, whether partial or total, is always irreparable and permanent.

2. It is impossible to obtain the sterilization of the testicle of the rabbit by one single irradiation unless acute or tardive radiodermatitis is produced, which always leads to cachexia and not infrequently to death of the experimental animal.

3. The massive dose which leads to injury of the skin varies from 4,000 to 4,400 r (Solomon) measured at the level of the testicle.

4. When using roentgen rays of medium penetration (180 kv.) a change of the filters between 0 and 8 mm. Al does not produce any appreciable difference in the relation of the ionometric dose and the gross biologic phenomena observed (radionecrosis, sterilization of the testicle).

5. The threshold dose of radionecrosis of the skin increases proportionately with prolongation of the time factor. Thus the dose of 4,400 r administered in massive radiation may be increased to about 6,200 r when fractionated into five equidistant parts, distributed over a period of thirteen to seventeen days.

6. This rule does not apply to the seminal tissue, the radio-injury of which does not diminish with prolongation of the time factor (up to a certain limit).

7. This discordant behavior permits, by a suitable arrangement of the time factor, a complete destruction of all spermatogonia without any serious injury to the skin.

8. Thus by utilizing a dose of 5,000 r, a sterilization of the testicle without any injury to the skin can be produced by fractionating the dose into four to five equidistant parts distributed over a period of four to nine days.

9. Such a procedure, at the same time, conveys a greater electivity to the radiation therapy.

10. The question as to whether or not the dose necessary for the sterilization is increased or decreased through fractionating and prolongation of the time factor remains unsolved.

11. There is an analogy in the response of the germinative spermatogonia of the seminal epithelium and of the mother cells of certain cancerous tissues toward roentgen rays. This analogy has induced the Radium Institute of Paris to use the protracted radiation therapy rather than the massive method for the treatment of all epidermoid cancers. The better results obtained seem to have justified the correctness of the procedure.

12. The biologic effects (as, for example, the erythema and the reactions of the mucous membranes) when used as units of measurement are not independent of the time factor. Consequently they cannot serve as absolute doses of measurement.

13. The conclusions of points 2, 3, 5 and 8 concerning the relation between the dose and the threshold of the biologic effects apply only for the quality of the roentgen rays mentioned. —*T. Leucutia.*

Lorimy. A propos d'un générateur à 400,000 volts. (Concerning a generator for 400,000 volts.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1931, *19*, 199–201.

The trend in modern deep roentgen therapy is to use more and more powerful apparatus. There is now an entire series of generators yielding more than 200 kv., most of them being of the pulsating current (300 kv., 400 kv., 600 kv.), and some of them of the constant tension (400 kv.) type.

The advantages resulting from increase in the high tension are: (1) increase in the intensity of the roentgen-ray beam, and (2) increase of the depth dose due to greater penetration. (1) Intensity of roentgen rays: (*a*) with equal electric intensity the electric power of the tube doubles when the voltage is increased from 200 to 400 kv.; (*b*) the roentgen output of the tube is proportional to the tension at its ends, amounting to 2 per 1000 at 200 kv. and 4 per 1000 at 400 kv. In correlating the two, it follows that the intensity of the roentgen beam is proportional to the square of the tension; in other words, that in a treatment, all factors remaining the same, the dose will be four times larger when the tension is increased from 200 kv. to 400 kv., the insertion of various filter thicknesses still further increasing this amount. (2) Depth dose. For the determination of this, experiments were carried out in water phantoms with a distance of 71 cm. and field of 7 cm. diameter, the ionization measurements being made on the surface of the water and at a depth of 12 cm. It was found (*a*) that a greater penetration is obtained by increasing the filtration at 400 kv. (as compared to 200 kv.); thus if one uses at 200 kv. and 2 ma. a filter of 1 mm. Cu, to obtain the same dose on the surface of the skin at 400 kv. and 2 ma. one may use a filter as thick as 6.5 mm. Cu, this increasing the depth dose from 22 per cent at 200 kv. to 34 per cent at 400 kv.; (*b*) that, on the other hand, an increased intensity on the surface is obtained with feeble filtration at 400 kv. Thus with 1 mm. Cu, by increasing the voltage from 200 kv. to 400 kv., the incident dose increases at the rate of 1:4.6, which means that a surface dose which can be obtained at 200 kv. in 46 minutes will be obtained at 400 kv. in only 10 minutes. If one uses 2 mm. Cu as filter, the incident dose increases at the rate of 1:6.

In comparing the quality and quantity of the roentgen rays obtained by these very high tension machines with that of radium, it was found that a quality of 0.02Å which according to the Plank law is the quality dominating the beam of the gamma rays of radium can be reached with 610 kv. The equivalent quantity of radium is more difficult to determine but it was thought that a tube functioning at 400 kv. and 2 ma. at 1 meter anticathode skin target distance would yield an energy equivalent to 425 gm. radium element acting at the same distance. Since, however, the radium usually is applied at a distance of only 10 cm., the equivalent energy at this distance would be 4.25 gm. of radium.

On the basis of the variation of the lead absorption coefficient for different wave length values (20 at 200 kv., 4 at 400 kv., and 2 at 600 kv.) it was calculated that if 5 mm. lead gives sufficient protection for 200 kv., 25 mm. will be necessary for 400 kv. and 50 mm. for 600 kv. Expressed in equivalent value of earth this would correspond to 70 cm. earth thickness at 400 kv. at 1 meter at 600 kv.—*T. Leucutia.*

GLOCKER, R., and REUSS, A. Strahlenschutzmessungen II. (Radiation protection measurements. II.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1930, *42*, 651–656.

I. Determination of the lead absorption coefficients. The German as well as the International protection rules provide a lead thickness of 5 mm. for voltages from 200 to 220 kv. A recent discussion with van der Tuuk and Boldingh has brought up the question as to whether this thickness is not too great. The measurements of Kaye, Berthold, Glocker and Reuss extended only to values as high as 4 mm. lead, the rest being calculated by extrapolation, which as is known is rather unsatisfactory. By using a Metalix therapy tube and a Küstner apparatus, the authors determined the lead absorption coefficient values per 1 mm. thickness for 200 kv. and 220 kv., and obtained the following figures:

	200 kv.	220 kv.
Increase from 2 to 3 mm. lead	18.7	15.6
Increase from 3 to 4 mm. lead	16.7	13.4
Increase from 4 to 5 mm. lead	15.7	12.9
Increase from 5 to 6 mm. lead	15.6	12.6

Thus the lead from 4 mm. thickness upwards shows a constant value of the absorption coefficient per 1 mm. (μ), this corresponding to 16 for 200 kv. and 13 for 220 kv. From a practical standpoint this means that each additional millimeter of lead produces a decrease of one-fifth of the radiation in 200 kv. and one-fourth in 220 kv. peak voltage. For example, if the lead thickness is increased from 4 mm. to 6 mm. the radiation with 200 kv. will decrease to $\frac{1}{5} \times \frac{1}{5} = 1/25$.

II. Protected tubes. The protection of two Multix tubes used for diagnostic purposes was tested by means of photographic and ionometric methods for 110 to 115 kv. peak voltage. It was found that this is quite satisfactory, the amount of radiation passing through the least protected portions of the tube being at 115 kv. ten times less than the amount of useful radiation behind a 1.5 mm. lead filter with identical focus distance.

III. The roentgenoscopic test. As is known, the International Congress at Stockholm recommended that the protection against roentgen rays be such that not the slightest fluorescence of the screen be observed in the dark after good adaptation of the eyes. More recently, following the recommendations of Hausser, Bardehle and Heisen there has been a tendency among German roentgenologists to increase this tolerance limit of the dose in roentgen diagnostic rooms. In repeating the measurements with the aid of the fluoroscopic procedure it was found that the tolerance dose indicated by Mutscheller (1×10^{-5} r/sec.) applies only to therapy rooms, while in the diagnostic rooms if a ten times increase of the tolerance limit is allowed the fluoroscopic procedure becomes valueless.—*T. Leucutia.*

Leddy, E. T., and Witting, Vito. The effect of varying volumes of air on the distribution of roentgen energy in a non-homogeneous medium. *Radiology*, Nov., 1930, *15*, 579–584.

Measurement of the intensity distribution of roentgen rays in the depths, as well as at the surface, of a paraffin block, are altered by various volumes of air and also by the relative position of the air with reference to the paraffin and to the ionization chamber. The greater the volume of air the greater are the changes noted. These are due to a balancing effect between decreased absorption and scattering of the incident rays in comparison with the absorption and scattering in a solid medium.—*J. D. Camp.*

Gfrörer, O., and Berger, Heinz. Über die Notwendigkeit der exakten Dosisangabe bei Arbeiten über Grenzstrahlbehandlung. (The necessity of exact dosage indications in the treatment with Grenz-ray therapy.) *Strahlentherapie*, 1930, *38*, 184–186.

Discussing a publication by Fuhs and Konrad on dosimetry in grenz-ray therapy, the authors insist that dosage data should always contain the peak kilovoltage, milliamperage, window skin distance and dose in r. They feel that these four indications are necessary to reproduce grenz-ray doses and that they are sufficient. The use of the half-value layer was abandoned by the authors, since it did not seem to yield satisfactory results.—*Otto Glasser.*

Bouwers, A. Röntgenröhren mit vollständigem Hochspannungsschutz bis 200 kv. (Roentgen-ray tubes with complete protection from high tension up to 200 kv.) *Strahlentherapie*, 1930, *38*, 157–164.

Bouwers describes a new 200 kv. roentgen tube which is built according to the Metalix principle and which is completely enclosed by a metal cover which can be connected to the ground. The high tension is led to the tube by two flexible cables which are insulated and also covered by a grounded metal sheath. The tube is water cooled, and can be suspended to any one of the standard tube stands. It is especially adaptable for use in a two-tube arrangement, as indicated by Fürst of Zurich. The maximum permissible current through the tube at 200 kv. is 8 ma.—*Otto Glasser.*

Boldingh, W. Hondius. Ein Oberflächentherapie-Apparat mit konstanter Strahlung. (An apparatus for superficial therapy with constant radiation.) *Strahlentherapie*, 1930, *38*, 165–172.

In order to avoid the large variations in the radiation output of therapy machines, especially in superficial therapy, which are mainly caused by fluctuations in the primary voltage, the author constructed an apparatus which makes use of the iron-hydrogen resistance, which passes a constant current within a given range of tension. This resistance is placed in a series with a high tension transformer and prevents line fluctuations from reaching the transformer. This arrangement, however, permits only the use of one given voltage and one given current. While this apparatus could not be used for general roentgen therapy, it lends itself very well to the construction of a dermatological roentgen apparatus. The author has developed a special therapy machine, using a completely protected Metalix tube which is mounted with the transformer on a movable stand. Between 200 and 240 volts the fluctuations in the primary of the transformer amount to only

3 per cent. The resulting variation in dosage is rather small. The apparatus, therefore, permits of measuring the dose by time only, and is furnished with a calibration table giving the treatment times for various focal skin distances, filters and size of area for a dose of 500 r. The peak voltage used is 45 kv. The dosage data and absorption values for this type of radiation are discussed and compared to those of the softer grenz rays and the harder roentgen rays usually employed in superficial roentgen therapy. —*Otto Glasser.*

Spiegel-Adolf, Mona. Secondary ultraviolet radiation. *Klin. Wchnschr.*, 1930, *9*, 1615.

Ultraviolet rays, roentgen and radium rays may produce coagulation of proteins dissolved in water. This can easily be demonstrated with a 1 per cent serum albumin solution. Since it is necessary to expose a very long time with roentgen or radium rays in order to cause coagulation, i.e., it requires enormous doses, the author studied ways and means to increase the effect of roentgen and radium rays. She used the fluorescent rays excited by roentgen rays or radium when striking, for instance, NaCl, KCl, or LiCl and KCl combinations.

They were most suitable since their fluorescent radiation is at an optimum around from 2800 to 3000Å. The salt crystals were placed in quartz tubes which were submerged in the solution. Albumin dissolved in water, 1 per cent suspension of sheep erythrocytes and paramecia were irradiated. It appeared that the effect of the fluorescent radiation was much higher than that of the primary roentgen or radium rays alone.—*E. A. Pohle.*